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British Grey and Malleable Cast-Iron Research Association.

Inaugural Meeting in Birmingham.

The efforts which have been made, largely through the instrumentality of the Institution of British Foundrymen, for the establishment of a British Grey and Malleable Cast-Iron Research Association in co-operation with the Government Department for Scientific and Industrial Research have been successful. The Association was inaugurated at a largely attended meeting of the cast-iron founding industry held at the Queen's Hotel, Birmingham, on Thursday, September 30. The Right Hon. the Lord Mayor of Birmingham (Alderman W. A. Cadbury) presided at the commencement, and gave a welcome to the representatives of the industry. On the departure of the Lord Mayor, who was called away by his Civic engagements, Mr. Matthew Riddell (Falkirk), President of the Institution of British Foundrymen, took the chair. There were also amongst those present Sir Frank Heath, K.C.B., Mr. R. A. Abbott and Mr. T. Oakley, from the Government Department of Scientific and Industrial Research; Prof. T. Turner, Dr. L. Aitchison, and Messrs. O. Stubbs, of Manchester (National Ironfounders' Employers' Federation), B. Collett, of Lincoln (British Engineers' Association), Isaac E. Lester (C. Akrill, Ltd., West Bromwich), W. R. Barclay (Wiggin & Company, Limited), J. F. Hardiman (Petters, Limited, Yeovil), J. E. Fletcher (W. Hingley, Limited, Dudley), W. J. Foster (Bradley & Foster, Limited, Darlaston), A. E. Broughall (Alfred Herbert, Limited, Coventry), Mr. W. Mayer (Hardie & Gordon, Dumbarton), Mr. J. Arnott (G. & J. Weir, Limited, Glasgow), representatives of The Derwent Foundry Company (1920), Limited, and Alfred S. Smith & Sons, Walsall; Mr. John R. Hyde (President of the Sheffield Branch of the Institution of British Foundrymen), Mr. G. S. Williams (President of the Cardiff Master Ironfounders' Association), Mr. Charles Sier (Secretary of the Sheffield and District Ironfounders' Association), Mr. Edwin Dempster (Secretary of the Ironfounders' Association of Ireland), Mr. Albert Parker (Tipton Tub & Tube Company, Limited), Mr. T. H. Mold (Mold &

LORD WEIR, PRESIDENT OF THE BRITISH GREY AND MALLEABLE CAST-IRON RESEARCH ASSOCIATION.

Son, Walsall), Mr. Thomas H. Firth (Wicker Ironworks, Sheffield), Mr. John Little (Manchester), representative of George Kent, Limited, Luton, Mr. J. Ellis (Kent's Hydraulic Engine Works, Luton), and the Secretaries of the Ironfounding Employers' Associations of Bolton, Bradford and District, Cardiff and District, Halifax and District, Ireland, Keighley, Leeds and District, Manchester and District, North of England, Welsh Engineers and Founders, Newport, Scottish Ironfounders, etc. F. J. Cook (Rudge Littley, Limited, Smethwick), E. Adamson (Sheffield), W. Macfarlane (Wednesbury), H. B. Weeks (Vickers, Limited, Barrow), F. C. A. H. Lantsberry (Birmingham Small Arms Company), A. Roe (Adaptable Moulding Machine Company, Birmingham), F. H. Hurren (President, Coventry Branch, Institution of British Foundrymen), S. Taylor (Taylor & Hubbard, Leicester), R. Lawson (Derby), A. E. Waring (Derby), D. H. Wood (Constructional Engineering Company, Birmingham), S. Grenes (Glasgow), E. R. Jones (Jones & Attwood, Stourbridge), L. F. Short (Birmingham Corporation Gas Department Research Laboratory), F. F. Sharpe (Wolverhampton), H. W. Lindop (Walsall), H. Lewin (Sheepbridge Coal & Iron Company, Chesterfield), J. H. Cross (Cross & Company, Limited, West Bromwich), D. W. Maddock (Oakengates), A. Oldbury (Wednesbury), E. Jones (Bradley & Foster, Darlaston), T. J. Southall (Hardy & Padmore, Worcester), G. Lewis (Perry & Sons, Bilston), M. B. Wild (Thompson & Southwick, Tamworth), R. W. Bender (Messenger & Co., Loughboro'), H. Hildrick (Hildrick & Hildrick, Walsall), A. B. Lisle (Pleck Foundry Company, Walsall), A. E. Tucker (Birmingham), H. W. Brownsdon, Ph.D. (Kynochs, Limited), J. S. Hadley (Stove Foundry, Blackheath), F. Powell (Stockton-on-Tees), R. F. Platt (S. Platt, Limited, Wednesbury), S. S. Smith (Manchester), D. Lewis (I. Harper & Company, Willenhall), F. Holberry (President, Birmingham Branch, Institution of British Foundrymen), A. Turner (Geo. Jones, Limited, Birmingham), J. E. Fletcher (W. Hingley, Limited, Dudley), A. Harley (Daimler Company, Coventry), R. O. Patterson (Blaydon-on-Tyne), A. J. White (Charcoal Iron Company, Ulverston), I. H. Westwood (Oldbury), J. Fearn (Birmingham Small Arms Company, Birmingham), R. Miles (Newton Chambers & Company, Sheffield), H. S. Kipling (Wolseley Motors, Limited), W. J. Molineaux (Dormans, Limited, Stafford), O. Kirk (Walsall), H. Greenhowe (United Brassfounders and Engineers, Limited, Birmingham), and T. Vickers (Acting Secretary).

Mr. T. Vickers, the Acting Secretary, announced that apologies for absence had been received from Lord Weir, Sir Herbert Austin, Sir Robert Hadfield, Sir Alfred Herbert, Dr. J. E. Stead (Newcastle), Dr. W. H. Hatfield (Sheffield), Mr. J. S. Cox (Mayor of West Bromwich), Mr. G. Pate (Falkirk), Mr. Arthur Stubbs (Smethwick Stamping Company), Mr. H. Cole Estep (European Manager, Penton Publishing Company, Cleveland, Ohio), Herbert Morris, Limited (Loughboro'), Bagshawe, Limited (Dunstable), Barrow Hematite Steel Company, Limited, Crossley Brothers, Limited, Brotherton Ediswan Tubes & Conduits, Limited, Blakeys Boot Protectors, Limited, Thomas Gameson & Sons, Limited, Walsall; Bullers, Limited, Tipton; Joseph & Jesse Siddons, Limited, West Bromwich; John M. Butt & Co., Gloucester; Mather & Platt, Limited, Manchester; the New Garter Foundry Company, Limited, Dudley Port; the British Griffin Chilled Iron & Steel Company, Limited (Barrow-in-Furness), John Wright & Company, Birmingham; Westwood & Wrights, Brierley Hill.

The writers in every case expressed approval of the proposal to form a Research Association.

Lord Mayor's Address.

THE LORD MAYOR said that the meeting that afternoon was to consider the proposal to form a British Grey and Malleable Cast-Iron Research Association in co-operation with the Government Department for Scientific and Industrial Research, and he had very great pleasure in giving a hearty welcome to those who had come from a distance, and some of them from very long distances, to take part in a conference for such a purpose. The iron industry was one of the oldest industries in the country, and was specially associated with the Midlands. The historian Leland, in 1538, wrote:—

> "*There be many smithes in the towne that use to make knives and all maner of cuttynge tooles, and many lorimars that make byts, and a greate many naylors, so that a greate parte of the towne is mayntayned by smithes who obtain their yren out of Staffordshire and Warwikshire, and their see coale out of Staffordshire.*"

This showed that in those days the industry existed in Birmingham, and was supported, as now, by raw material from the counties. He thought he was correct in saying that in those days there was a great deal of beautiful craftsmanship in the industry, some of which reached to high art, as they would see if they inspected some of the examples in the Industrial Department of the Birmingham Art Gallery and Museum. But during the Victorian era many of their industries seemed to lose something of that craftsmanship and art as they developed into a wholesale scale of production and gigantic concerns sprang up, sometimes with dingy and grimy not to say even ugly surroundings. Perhaps he was correct when he said that was the impression some of them had of the iron industry as it had developed in this country. He very much hoped that the scientific research which they had met to encourage would be able to take within its scope such questions as the relation of the industry to its surroundings as well as the very important questions relating to the material itself. When he read their circular it struck him that the fact that such a very old and well-established industry started with the frank admission that it had much to learn, was the very best augury for the success of the new Association.

The Government had set aside a certain sum of money to promote such research, and he was very glad that the iron industry was prepared to take advantage of that offer. He felt it an honour to be able to welcome so many representatives of that highly important industry from all parts of the country, and he hoped that their meeting in Birmingham would have very useful and far-reaching results.

MR. RIDDELL then took the chair. He said that

on behalf of the Provisional Committee and the various Associations and firms represented at that meeting it devolved upon him to express their appreciation of the great honour which the Lord Mayor had conferred upon them by being present, and their thanks to his lordship for his address of welcome, which was at once interesting and instructive. As the Lord Mayor had said, the iron trade was a very old and a very important one. Someone had described it as the daily bread of all other industries. He was glad that that meeting was being held in Birmingham, because a good deal of that daily bread was made in the Birmingham district—and those engaged in it seemed to thrive very well on it. It was true that the scientific aspect of their trade had been very much neglected; there was really no completely formulated body of science connected with it. That might be due to the fact that ironfounders were proverbially conservative, and it might be said that that was because so many of them were Scotsmen. He found in the course of his peregrinations that iron manufacturers and foundries and others engaged in the trade were all prepared to admit in the abstract the advantages of science. It was, however, difficult to get them to put science into practical use. He hoped that as the result of that meeting in Birmingham they would be able to bring about a much closer union between science and their industry than had hitherto been the case. He had much pleasure in proposing a vote of thanks to the Lord Mayor for his presence at that meeting and his valuable words of encouragement.

Mr. Oliver Stubbs (Manchester), in seconding the vote of thanks, said that they in Manchester had felt for a very long time that they needed more recognition from the Municipal authorities. They believed that if the Corporation would give them educational schemes of a more practical nature they would make much more rapid progress. Therefore he considered that the presence of the Lord Mayor of Birmingham that afternoon was a good augury. He hoped, also, that in the work of their Association they would not forget to take into their counsels the employees of the foundry industry. He thought the employees might as profitably spend some of their time in promoting and assisting research work as on wages questions, because research work would help to bring about what they all desired so much — increased production — and that would enable increased wages to be paid. He trusted that the kindness of the Lord Mayor in coming there to give them a welcome would be amply repaid by the results which would ensue from that meeting.

The vote of thanks having been carried by acclamation, the Lord Mayor briefly replied, and again expressed the hope that they would have a very successful meeting.

Government Scheme Explained.

Sir Frank Heath, K.C.B., who was called upon to explain the scheme from the point of view of the Government Department for Scientific and Industrial Research, said that he realised that there was not the slightest necessity for him to urge the need or the desirability of research. He would, however, like to refer to one or two questions which had occurred to him during the stay he had made in that neighbourhood for the last ten days. He had been most hospitably received in many directions, and had seen a very great deal of the trades represented at that meeting. One of the thoughts which he had gathered was that the first incentive to new ways was competition. He was told that competition had affected their trade from various directions, and notably from the United States, where a Research Association had already been founded. He was told that most promising results had already been obtained in America, and that among them it was claimed that the Americans could make malleable castings of more than 50 per cent. greater tensile strength than hitherto. If it were true it was a serious matter. But the competition was really nearer home, for he learned a few days ago an Association of Light Castings Manufacturers in Scotland had established a research laboratory, and he was not aware that there was anything corresponding to that south of the Tweed. If that was an example of the conservatism of Scotsmen it struck him as rather a good thing. In the course of his peregrinations during the last ten days he visited a factory which was turning out pumps, and the head of that business said to him, "Now, if I could only get grey-iron castings which would be free from corrosion by salt water, I could substitute iron castings for bronze for shipping purposes and save an enormous amount of cost to the Navy and to the Mercantile Marine." Whether that was an insoluble problem or not he could not say, but he thought it was an example of some of the problems with which a Research Association might deal. During the last ten days he had asked a great many questions, and it had been borne in upon him that the first necessity, if perfectly satisfactory production in the foundry trade was to be ensured, was that they should know accurately what they were getting in their pig-iron. They must be certain of the quality and the contents and the characteristics of the iron with which they had to deal. Were they certain? Then they must know, of course, what should be the proper constitution of the iron for the purposes of the castings which were to be made from it. That was a matter for scientific research in a laboratory. Such questions could only be solved on a small scale. They had to be solved in the first instance in the laboratory, but, supposing one of these questions to have been so solved, could they be sure that the quality would be maintained in manufacture? To be sure of that they had to know a number of things; they had to know exactly the reaction set up in the furnace between the refractory and the metal. Did they know that? They must know exactly the right temperature, not only for the melt but also for the annealing. Did they know those temperatures? If they knew all those things the problem was comparatively simple. But if they did not, then such a problem could only be solved by the industry itself undertaking research, and not relying merely upon laboratory research or even upon the engineer or authorities on refractories. Such questions as these and the attitude of the trade towards them made it certain that there was room for more scientific and industrial research than they had had in the past. The question they had to answer for themselves, and which no one else could answer for them, was whether or

not such research could be carried on in the right way by a Foundry Research Association. He did not claim for a moment that research associations were the best means in all circumstances for getting scientific results which would be useful to an industry. For instance, there might be an industry in which they had a large number of big economical units, each with enormous capital, specialising on a particular product or range of products. In such an industry, in all probability, research could be done as effectually by those single big units as it could be done in co-operation. They had to deal with an industry in which there were many big firms, but where many of those big firms were not mainly concerned with foundry work, though foundry work was a part of their business, whilst there were also many other firms—smaller firms which, perhaps, specialised in foundry work. They had there a condition of things which was analogous to that of the man who owned ships in the Mercantile Marine. There were large firms such as the Cunard Line, and there was the man who owned, perhaps, only two or three steamers. The shipowner did not take upon himself the whole risk, but divided it with other insurers through an insurance company. Now, the application of scientific research to industry was really nothing more than an insurance against the evil effects of ignorance. But it differed from ship or fire insurance because in the latter case one was insuring against a possibility that might never occur, whilst if they were insuring against ignorance they were insuring against something that was as certain as death. They therefore wanted a means of co-operative organisation which would enable a number of firms to pool their resources in order to get bigger and better results than any one or even any two or three of them could get. Such an association would be able to undertake investigations which might bring in very big financial results as well as to undertake investigations upon matters which would only bring in small amounts. It would be able to collect information as to the best practice in their own and other countries, and put that technical information immediately at the disposal of every firm in the Association at a cost far less to each member than would be the case if any one firm attempted to do the work for itself. A firm which established an information bureau for the purpose of collecting all the best practical results in definite form would incur an annual expenditure running into four figures. But if that work was done through an Association combining, say, the 2,790 firms in the foundry trade, the expenditure falling upon each firm would be a bagatelle. He thought this showed that the formation of a Research Association in which all the firms co-operated for this single purpose was likely to be a solution of their difficulties. Dealing with the constitution and functions of the proposed Association, Sir Frank said that the scheme was that firms in the industry should undertake to make a subscription for a period of years. The Government, with the experience they had acquired since the movement was started in 1916, had come to the conclusion that it was not worth while to look for results in research in a period much under five years. They might get some results in less time, but they could not really decide whether the Association was going to be a success without a five years' trial. It was therefore suggested that firms should guarantee contributions for that period. It was also suggested that the contributions should be relative to the size of each firm, and it would be for the Council of the Association to work out a scheme of contribution on those lines. The bigger firms ought to contribute more, because as a rule they could make more use, as to many scientific results, of the knowledge obtained. There would be some results perhaps, which could be used by big firms but which the small firms could not use at all. As to the guaranteed income that would be necessary the members must decide for themselves. The Government, however, as it was going to make a contribution towards that income, must fix a minimum. It was of no use undertaking such work in a mean way, and therefore the Government said that if the industry did not contribute a certain minimum the Department would not give them a penny. Their opinion was that, for an industry of that extent and importance, the total income of the Association ought to be not less than £5,000 a year, inclusive of the Government contribution. They had to pay good directors, and such men would not be got for nothing. When they came to closer quarters the Government would want to negotiate with the Association as to how much further they would aid the Association upon the basis of giving pound for pound. Such an association ought to spend £50,000 a year, but the Government could not go on aiding it up to any amount in the same proportion. It should be remembered that the Department of Scientific Research only had a million pounds to start with, and it looked as if shortly there would be only £200,000 left, whilst there were still other industries wanting to come in. The Government, therefore, proposed for this Association to give a contribution at the rate of pound for pound up to £2,500, making the income £5,000 a year. For all contributions from the industry above £2,500 the Government would add 10s. in the £, and then there would be a further limit, at which the addition would be only at the rate of 5s. in the £. The Government aid would not be guaranteed longer than five years, for the very good reason that at the end of that period they ought to know whether the Association was going to be a success or not. If it was not a success they would want to get out of it, but if it was a success the firms would want to have it absolutely in their own hands. On the other hand, they would not want their income to drop too suddenly, and that was why the scheme was designed so that the Government contribution should show a falling curve during the five years' period. The Association would be a Limited Liability Company which could not make any profit and could not distribute any profit except in the form of knowledge. Any money which was made would go to the Research Fund. The Articles and Memorandum of Association would have to be approved by his Department and the Board of Trade, but as far as the Board of Trade was concerned the principal matter was whether the firms associated were British firms, and he thought those present would not quarrel with that. His Department would have to be satisfied that the funds were guaranteed, that the Council of the Association was likely to work well, and represented not only capital and management but also scientific knowledge. Very often

Associations arranged to give representation to members of learned societies. Then, whilst they did not make it an absolute condition, they urged all industries to include in their Councils representatives of Labour. The Department did that because they believed, and had seen evidence of it, that an industry the employers of which told its workers what they were out for, and what were its difficulties and how they proposed to get round those difficulties, and what was the effect of certain changes, got along much more smoothly than did an industry which did not take the men into its confidence.

They also thought that the workmen, though they might not be able to bring to bear profound scientific knowledge or any scientific knowledge, could bring forward the difficulties of their work and point out the effect of various conditions, not only upon the processes, but also upon the conditions and the efficiency of the worker. Their opinions might also be valuable with regard to the lay-out of foundries, and he was sure there were many cases in which foundries might be improved in that respect. He heard recently of a firm which had spent £50,000 upon its foundry and had been very much criticised as to certain of its arrangements. Therefore he could not help thinking that the presence of workmen on the Council was sure to be of value. Then amongst the Research Associations which had been established there had been raised the question of better education and of getting the best type of workmen into the trade and providing suitable education for them. Reference had been made that afternoon to the shortcomings of local authorities, and a question had been asked, how many university courses in ironfounding were there in this country? He would not answer that question; he would ask them to answer it for themselves. How many Universities were there with Faculties of Technology? A similar question might be asked in regard to the technical schools. How many of them were giving practical instruction such as was desirable for the foundry industry? Could the number of such schools be counted on the fingers of two hands; and, even if so, how long had such courses been in existence? And yet they were dealing here with the very basis of a large part of the national industry. If there was one thing that the English workman believed in it was education. Their Association, if it wished, would be able to spend money on education, and, although his Department would not be able to contribute for that purpose, as it was not an educational authority, any contributions made by the members for the purpose would be deducted from their assessments for Income Tax and Excess Profits Duty. There was great scope for such associations to spend money on education, and no doubt when they began to do so the local authorities would begin to wake up. There might be an objection made by some big firms to contributing to the work of the Association. For instance, the firm which he had mentioned as spending £50,000 might ask why, when they had spent that money, they should be expected to put that money to the common good. The reply was, "It will pay you to do so, but we are not going to force you to do it." In the draft constitution of such associations there were clauses which would enable a firm to appeal against the Association undertaking an investigation which that firm had already commenced. He did not believe that would ever come into operation, but the security was there. Another objection, perhaps the most serious objection of all, was, "This sounds very nice, but we know what Governments are, and the less interference we have from Government Departments the better." He quite agreed with that and the proof that his Department agreed, was that they meant to be out of it in five years. There would be a certain measure of control, but it would be subject to certain limits. In the first instance the Memorandum and Articles of Association would have to be approved, but when the Association was once founded the Government did not interfere. They asked the Association to submit their programme and accounts, but the Association was left to work out its own salvation. The results would be their property and not the Government's, and though the Government might give half the money at first they took no share in the ownership of the results. Everything was held by the Association in trust for the purpose for which it was founded. But in common fairness each Association was expected to tell the Department what its results were, because the Department was aiding other industries, and one Association would often get results which overlapped another industry. The Department therefore wanted to be a Clearing House for results which were likely to be of value to other Associations. They were prepared to pass such results on at a price, but they did not want one Association to crush another by charging too much. The Department took the power to inspect, but that meant that in course of time they would be able, from their Bureau at headquarters, to give information. Very often this Bureau might be able to give information collected from abroad more rapidly than the Association could get it, and generally by inspection the Department would be able to give useful advice. Beyond that they did not claim control. They had, however, in reserve the big hammer, or what they might call the "mailed fist." They reserved the right to decide whether money was being spent on research, and to say if necessary, "That is not research; that is business, and we will reduce our grant." No doubt at the end of the five years the Association would find the Department sufficiently useful to desire to continue in friendly relations with it. But there would be no compulsion. He thought he had given them a fair picture of what might follow as the result of their forming a Research Association for their industry, and he left it for them to consider whether or not it was worth their while to go on with it.

Research Association Proposed.

DR. L. AITCHISON, in moving "That a Research Association be formed for Grey and Malleable Cast-Iron," said that no doubt many of them had had the experience of meeting some elderly gentleman who said, "I wish I had had the opportunity when I was young of learning as you do now. If I had I should be not only wealthier but also happier." They knew that this desire for education had been spreading amongst all classes, and, as Sir Frank Heath had said, was nowhere more evident than amongst the working classes. There were firms which, like individuals, might wish that when they were

younger they had had opportunities of going to school, of finding some teaching institution which would furnish them with knowledge particularly useful for their business. Unfortunately, until recently, such opportunities for firms were scarcely in existence. He thought that the cast-iron industry had come to the conclusion that an Industrial Research Association would provide a means by which such firms could make up for the absence of such opportunities in their early days. A research association might really form a university for firms, and a university was just as important and as useful for firms as for the individuals who composed those firms. But the great difference between a university for firms and a university for individuals was that in the former case the firms were both professors and pupils, all learning from each other and not dependent on any external person or authority for the information they were going to get. He had had a certain amount of experience in research work in industry, and had been connected with other research associations, and he had come very definitely to the conclusion that what they should look for was not results but research. If they looked for results at first they would be disappointed, but if they continued the research the results were bound to follow. That had been seen time after time. He was told that in America the malleable-iron industry alone produced work amounting to 1¼ million tons per annum, whilst in this country the rate of production in 1917 was only 76,000 tons per annum. He did not suggest that by research they could increase the output of the British industry to such an extent that it would equal that of the American industry. He was, however, told on very reliable authority that one of the principal causes for the marked increase of output in the American malleable iron industry in recent times was the research work that had been done upon its fundamentals. He thought it was agreed that cast iron, whether in malleable form or in other forms, really represented the Cinderella of British industries. Saving the presence of Professor Turner, one of the few gentlemen who had applied themselves to investigations with regard to cast iron, this metal had been very seriously neglected by their industrial and metallurgical scientists. They recognised that the time had come for the industry to take this medicine, and if it were properly administered the industry would benefit materially and in every other direction. It was, of course, possible, as Sir Frank Heath had said, for a certain amount of research to be done by individual firms. That was being done in most industries, though perhaps in the iron industry less than in any other. But the results required in the iron industry were such as would benefit the industry all along the line. Research was required both by makers and users. There were 2,796 makers of cast iron, and if all those gentlemen were doing individual research they were going to find something. But the number of the users of cast iron was almost impossible to estimate, and it was equally to their advantage to find out as much as possible. Take the users in the automobile industry, the Diesel engine industry and air craft industry. None of them knew yet all about the castings they used. A man who had to put in a cylinder could rarely tell whether it was properly cast or not, or how it was going to behave in the engine. The engineer could help us to find out a good deal more than we knew at present about the cast iron he used. It was only by an association like that now proposed that they could obtain the desired results, and he trusted that in the Association the users would be given a certain amount of representation. There were many things which had come under his notice as the result of his own experience of cast iron during the last three or four years. The mechanical properties were not fully understood, and the relation of mechanical properties and chemical composition required investigation which might mean a lifetime of very, very hard work.

Mr. F. J. Cook (Smethwick), who seconded the proposition, said that he took their presence at that meeting as showing that they believed in the need for such an association. The need had already been practically recognised by the formation of two special Research Associations. The Diesel users and the Diesel engine makers hoped by the formation of an association to find a means of getting over difficulties which were greatly hindering the output and the efficiency of that class of prime movers. There was also an Association in Scotland, with the formation of which their chairman had had a great deal to do, and which dealt particularly with research in regard to light castings. It was found that by means of such associations many difficulties could be faced and overcome. Those present were primarily business men, and naturally wanted to know what they were going to get and what it was going to cost them. The total amount required would certainly be very large, but they had over 2,700 firms in the industry, and if 2,000 of those contributed each £5 a year, that would be £10,000, and if they got another £10,000 from the Government that would adequately meet their expenses in the early stages. He thought there was no foundry, however small, which could not afford £5 a year for such a purpose, especially as it would be free from Income Tax and Excess Profits Duty. As to the results obtained in America, he happened to know a great deal about the American Association. That Association had not as yet been in existence five years, but the results had been marvellous. Not only had a great and increasing number of results been obtained, but the improvements in practice had been stabilised; the results obtained were not spasmodic results, but were obtained very regularly, and the industry benefited by the research work of the whole of the firms in the Association. Each member sent in regularly his quota of test bars, and if these were up to a cetain specification a certificate was given to the firm which was accepted by engineers generally as a guarantee of that firm's products for the next six months. If the test bars of a firm did not come up to the specification the whole matter was gone into, and generally the Association put that firm right in a very short time. Those who were members of the Association in America, he thought, would not come out of it for thousands a year. If they formed a similar Association in this country he believed that whilst the cost would not be great the benefits to the industry would be enormous.

Mr. W. R. Barclay, in supporting the proposition, said that he worked entirely on the non-ferrous alloys, but he had been for a number of years intensely interested in scientific research generally as applied to the metal industries of the country. He thought that two words should

stand out prominently in such proceedings, research and co-operation. To get at the root cause of things was an absolute necessity in all industrial progress. It had been said that success in anything only meant the necessity for a further and a greater struggle. He would go further, and say that it was only as one attained success that one could claim a further success, and that was illustrated in the industrial history of the country. He did not think they need be pessimistic about the future of British industry. If they had advanced so far in spite of the inadequacy of their facilities in the past they might look forward to a much more productive era under the new conditions of research. The question arose whether a research association of the type proposed was the right thing for such an industry as theirs. It had been said that if the Government had simply deposited a million pounds in trust for, say, three of the principal technical universities of the country and the National Physical Laboratory, results would have been obtained much more readily, and to a greater extent than by forming new organisations. He did not think that statement touched the real basis of the subject. He believed that the Government had done right in deciding to distribute the money amongst those engaged in the actual production of the manufactures concerned. It seemed to him that the atmosphere of a university or even of the National Physical Laboratory was not the right atmosphere in which to deal with the practical problems of the manufacturer. These could only be dealt with satisfactorily in consultation with those who were constantly face to face with conditions which must alter or modify any industrial problem. Investigation into the basic causes of things—in other words, industrial research—must be carried out hand in hand with the actual conditions of the industry and the men who were responsible for the industry for the time being. He would go to the length not merely of so governing the researches placed in the hands of their scientific men, but would strain every nerve to have the researches carried out in the individual works. He believed that as they got a broader outlook in industry that would be possible. It was quite evident that unless industry in general took the matter of research into its own hands it could not get the full advantage from research that it ought to get, and that could not be obtained even though research might be carried out by the most brilliant scientific men of the day. It was also essential that there should be complete co-operation amongst the various members of the industry. It had been pointed out that afternoon that very few, if any, individual firms could tackle properly one single phase of any subject which came up in industrial research. During the war he had to investigate a number of factors which tended to success in the production of sound ingots, and he found that one might write down no fewer than thirty separate factors which made for success or failure. A proper study of those thirty factors would involve investigation by a highly-trained mechanical engineer, a very efficient mathematician, a first-class manipulative chemist, a physicist of no mean order, and above them all a controlling mind to keep an oversight of the whole of the problems and dovetail the results together. He thought that was a sufficiently eloquent fact in testimony of the need for complete co-operation in industrial research.

Mr. B. Collitt (Lincoln), in further support of the resolution, said that he had paid several visits to America. There was no comparison possible between the industry in that country and in Great Britain, because in America raw material was graded by analysis and the industry was based upon the laws of Nature, whilst in Great Britain it rested mainly upon fallacy and empirism. The American Malleable Iron Research Association had recently requested the American Society for Testing Materials to raise the specification for malleable cast-iron. This showed the progress that resulted from applied research. The booklets of the American Association gave results which showed that success in producing malleable castings was simply proportionate to the determination of a firm to succeed. He hoped that in five years the Association they were now forming would be able to give them similar information.

Mr. Oliver Stubbs (Manchester) remarked that in order to get the grading of pig-iron they must form an association. If the makers found that iron which did not comply with standard analyses was rejected, the foundries would get what they wanted. But they must first find out through their Association what they really required.

Mr. E. Adamson (Sheffield), in supporting the resolution, said that he was glad that the question of malleable cast-iron had been raised. Having been connected with the trade from the pig-iron side for twenty-five years, he was convinced that they could beat the Americans in making malleable castings if they had the proper materials to start with and proper annealing. With regard to ordinary cast-iron, the subject had been almost neglected; there had been very little practical work done on it. There were the mechanical properties of pig-iron to be investigated, as well as the chemical, before they could produce a satisfactory pig-iron. They knew that two furnaces could work with approximately the same chemical analysis and yet produce totally different results. The conditions with regard to steel, and particularly melted steel, were pretty well known. The impurities of melted steel might be about 1 per cent. in weight and up to $1\frac{3}{4}$ per cent. in volume. But in ordinary foundry, grey and pig-iron the impurities might be 8 per cent. by weight, whilst with 3 per cent. of graphite they might amount to 50 per cent. in volume. There were, in fact, all kinds of combinations possible in pig-iron and cast-iron, and a great deal of research work was necessary.

The proposition was carried unanimously.

Professor T. Turner, in proposing a vote of thanks to Sir Frank Heath for his address, said all would agree that there was a wide field for the research which the Association was going to undertake. (Hear, hear.) They would have to deal not merely with the structure and the chemical composition of pig-iron upon which work had been in progress for a long time, but would have to consider such questions as the temperature of pouring, the rate of cooling, and the impurities which might come in or be removed during melting. They would also have to consider such questions as the pressure during casting, the head of metal, the composition and texture of the sand and dressings of the mould.

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the amount of blast employed in the cupola and the additions that were made in order to reduce the amount of sulphur or other elements which might arise either from the fuel or the scrap. These were a few only of the fundamental and elementary questions which would come before their Research Association. He hoped that the Association would get men of experience, of energy, and of reputation who would be able to carry on researches to such an extent as to give them a large body of scientific knowledge which would be of practical use.

MR. H. L. REASON (Birmingham), in seconding the vote of thanks, said they would all agree that everything in relation to the scheme had been well and fully placed before them. None of the speakers had alluded to the Institution of British Foundrymen, which could claim to have set the ball rolling towards the formation of the Association. The Institution of British Foundrymen was composed mainly of the workers in the industry. They felt that their facilities for gaining and applying scientific knowledge were insufficient, and that nothing further could be done unless the employers came in and took their share. That Association would be the means by which the employers could do this, and he hoped that it would succeed in obtaining valuable results which could be handed down to those who had to run foundries in the future.

SIR FRANK HEATH acknowledged the vote of thanks, and advised the promoters of the Association in drawing up their Memorandum and Articles of Association to consult his Department and particularly Mr. Abbott. By so doing they would probably greatly reduce their solicitors' costs.

Provisional Council.

The CHAIRMAN said that the work so far had been done by a provisional committee appointed from the Council of the Institution of British Foundrymen. That Committee had worked very hard, and had spent a great deal of time in attending meetings all over the country. He would like to bear testimony to the work Mr. Vickers had done. Mr. Vickers had been untiring in his efforts, and had shown great enthusiasm. They had been successful in getting the consent of Lord Weir to act as the President of the Association. Lord Weir had expressed his willingness to undertake the office, and did not want to be merely an ornamental member, but hoped to attend the meetings, especially when important business was coming on.

Nominations were then received for the Provisional Council, which with the members elected at the meeting will be constituted as follows:—Lord Weir (President); Mr. Douglas Vickers, M.P. (Sheffield), Vice-Admiral Sir George Goodwin, K.C.B. (President of the Institute of Metals), Sir James McKechnie (Barrow), Mr. P. W. Petter (Yeovil), Mr. A. A. Laing, C.B.E. (Wallsend), Dr. J. E. Stead (President of the Iron and Steel Institute), Sir Charles Wright (Baldwins, Limited), and Mr. F. E. Rebbeck (Harland & Wolff, Belfast), Vice-Presidents. Mr. H. J. Yates (John Wright & Company, Birmingham), Mr. H. B. Weeks (Vickers, Limited, Barrow), Mr. F. J. Cook (Birmingham), Mr. Matthew Riddell, of Falkirk (President of the Institution of British Foundrymen), Mr. A. F. Mason (Barrow Hematite Steel Company), Mr. J. Arnott (G. & J. Weir, Limited), Mr. G. Pate (Carron Company), Mr. O. Stubbs (J. Stubbs, Limited, Manchester), Mr. F. J. Taylor (Taylor & Sons, Limited, Briton Ferry), Mr. W. J. Foster (Bradley & Foster, Limited, Darlaston), Mr. E. Adamson (Sheffield), Mr. C. Retallack (John Harper & Company, Limited, Walsall), Mr. F. C. A. H. Lantsberry (Birmingham Small Arms Company), Mr. W. B. Parker (British Thomson-Houston Company, Limited, Rugby), Mr. F. J. Hardiman (Petters, Limited, Yeovil), and the following members nominated by different institutions:—Prof. T. Turner (Iron and Steel Institute), Dr. W. H. Hatfield (Institution of Automobile Engineers), Mr. W. B. Wedmore (Institution of Electrical Engineers), Mr. A. Turner (Institution of Mechanical Engineers), Mr. H. L. Reason (Institution of British Foundrymen), and Mr. W. J. Livens (the British Engineers' Association).

On the motion of Mr. Isaac E. Lester, seconded by Mr. Buchanan, a vote of thanks was passed to Mr. Riddell for presiding.

The CHAIRMAN, in reply, said he believed that the establishment of the Association would prove a good thing, not only for their industry and those engaged in it, but also for the country.

The Provisional Council has appointed Mr. H. J. Yates to act as chairman and Mr. H. B. Weeks and Mr. F. J. Cook vice-chairmen. Mr. T. Vickers has been appointed secretary.

Malleable-Iron Foundries in Great Britain.

According to Mr. Arthur Smith, formerly Assistant Controller of the Forgings and Castings Department of the Ministry of Munitions, the number of firms in 1917 producing malleable-iron castings was between 160 and 170. The total output per week was between 1,400 and 1,500 tons, or an average of 9 tons per week for the whole of the firms employed. The number of men employed in the industry was between 7,500 and 8,000.

Professor T. Turner, commenting on this paragraph, says that the number of firms in the United Kingdom interested in the malleable cast-iron trade in 1918 was 162, whilst the average output per month was 5,500 tons. This gives an annual output of 66,000 tons, whilst that of America is put at 1½ million tons.

A return compiled in preparation for the inaugural meeting of the British Grey and Malleable Cast-Iron Association, and dated September 30, 1920, gives the following particulars regarding the location and number of malleable-iron foundries in England, Scotland and Ireland:—

North Counties.—Northumberland, Cumberland, Durham, Westmorland, Lancashire, Yorkshire, 881. *Midland Counties.*—Staffs., Worcestershire, Warwick, Leicester, Derbyshire, Notts., Northamptonshire, 828. *West Counties.*—Wales (84), Chester, Salop, Hereford, Monmouth, Gloucester, Somerset, Devon, Cornwall, 321. *East Counties.*—Lincoln, Norfolk, Cambridge, Hunts., Suffolk, Essex, Beds., Bucks., Herts., 174. *South Counties.*—Berkshire, Wilts., Dorset, Hants., Sussex, Surrey, Kent, Middlesex, Oxford, 137. *London,* 98. Total, 2,433. *Scotland,* 305. *Ireland,* 52, making a total of 2,796 foundries in Great Britain.

The largest single-town foundry area is at Birmingham, where there are 118 foundries, the largest county foundry area being Yorkshire, with 408 foundries.

Making Castings for Rolling-Mill Construction.

Address before Birmingham Foundrymen.

The Birmingham Branch of the Institution of British Foundrymen opened its new session on October 2 at the Municipal Technical School, Suffolk Street, Birmingham, when Mr. F. Holberry (Branch President) delivered his presidential address. Mr. C. B. Roe (Vice-President) was in the chair.

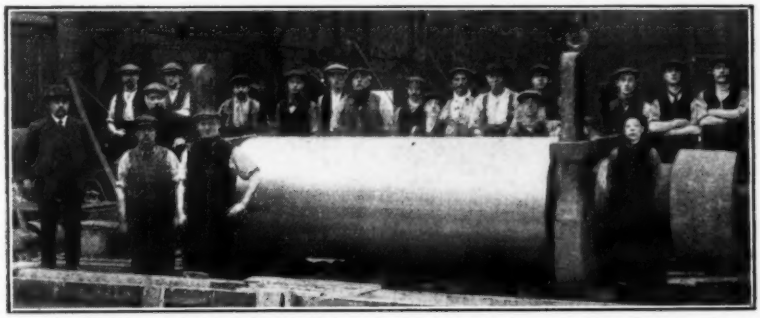


FIG. 1.—FINISHED CHILLED ROLL, 42-IN. DIA. BY 9-FT. 6-IN. LONG, FOR ROLLING SHIP-PLATES.

Mr. Holberry took for the subject of his address the making of castings for rolling-mill construction. He said that there were several kinds of rolls used in the construction of rolling mills, namely, grain rolls, chilled rolls (hard and soft), and rolls made of steel. He would deal, however, only with those made of cast iron, as he had had no experience in the making of steel rolls. The rolls cast in sand were commonly known as grain rolls on account of the grain in the metal being very conspicuous when the rolls had been turned. These were all cast in dry sand. Smaller rolls, from about 8 in. to 14 in. diameter and plain, were rammed up from a full pattern, with necks and wabblers set up on each end. The larger rolls were swept up in half boxes with sweeps cut out to suit all sections required. These were dried and then put together by the joint, stopped in well, clamped together, and then reared up and put into a casting pit. The casting pits were so arranged that the metal could be tapped direct from the furnace into the mould in the case of all large-grain rolls. The metal was melted in

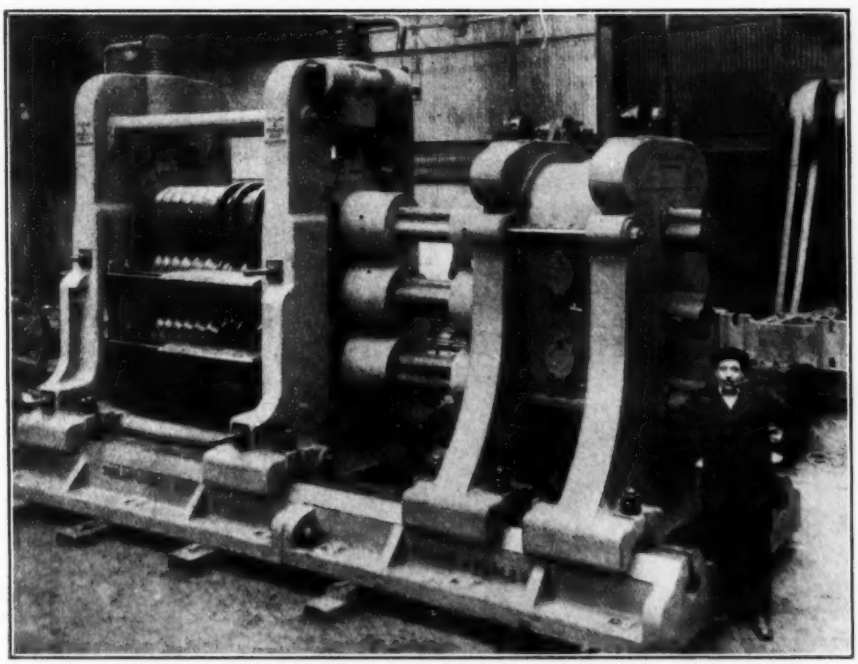


FIG. 2.—22-IN. 3-HIGH MILL FOR ROLLING LIGHT SECTIONS AND RAILS.

air furnaces for nearly all kinds of rolls, as this allowed them to use up any amount of large scrap, such as parts of broken rolls, etc. They were also

43 in. diameter and about 10 ft. long. In the moulding of these rolls the necks and wabblers were rammed up in sand, so that there was no

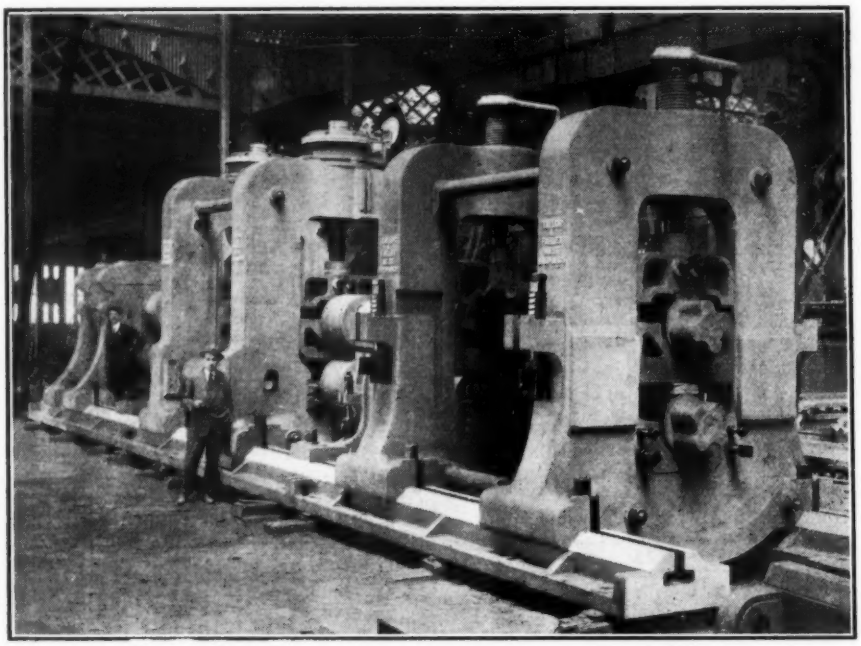


FIG. 3.—28-IN. ROUGHING AND FINISHING MILL FOR TINPLATE BARS.

able to take off a trial, cool and break before casting. These trials were only taken for depth of chill.

Chilled rolls were so called because they were

danger of chilling taking place in them. Then the body, or, as it was sometimes termed, the barrel, was made up to the length with cast-iron chills. The shorter rolls were always made in the one

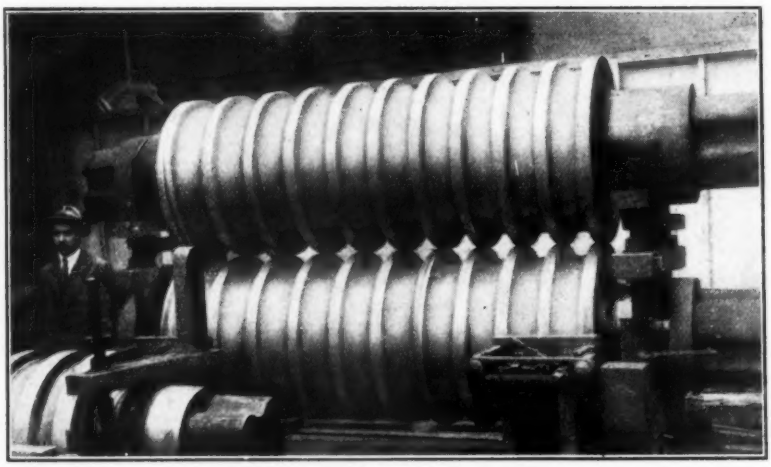


FIG. 4.—ROLLS FOR ROLLING ROUND BARS.

cast in iron moulds, and, through rapid conduction of the heat, a definite depth of chill was obtained on the face of the barrel. Such rolls were made from about 8 in. diameter and 8 in. long up to

chill, but with the longer ones sometimes three or four chills were required to get the desired length of the body. The rolls were always cast from the bottom neck, with a spinning gate, so

that whatever dirt accumulated during pouring, was kept in the centre of the metal and was carried away through the riser or feeding head.

It would perhaps be as well to explain how the down runners were carried to the in-gate. With the small rolls there was provision made on the chill by casting on an open pocket, so that the gate could be rammed up inside. With the larger castings, where several chills were used, this was not advisable. These were rammed up in segment pipes about 2 ft. 6 in. long, and brought up from series of pinholes towards the top of the roll, and this was always fatal in chilled rolls. If the chills were in good condition and free from cracks it was always safe to cast at a fairly high temperature. From a series of readings at his own works they had proved this to be so, whether they were casting chilled rolls or grain rolls. They knew from experience that the life of these moulds was not indefinite. It might be prolonged sometimes by re-boring, but this did not always follow, and it was a good plan to keep new chills

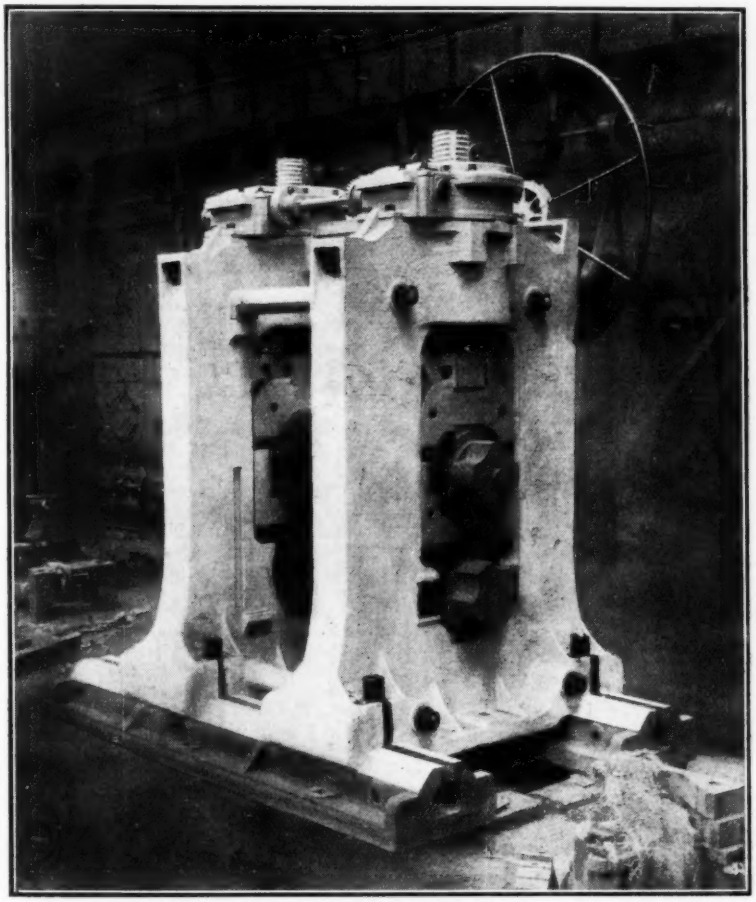


FIG. 5.—30-IN. MILL FOR ROLLING BRASS PLATES.

the bottom-neck box outside the chills to just above the feeding head. Then the casting bosh was placed on the top of these to receive the metal. When this bosh had been filled, and the plug drawn, the remainder of the metal was poured from the ladle. The quicker the castings were run the better the results obtained. He believed he was right in saying that they could pour a 26-ton chilled roll in about 58 seconds from the time the plug was drawn.

Casting temperature played a very important part in this class of work. If their casting temperature was too low they were liable to get a

of standard sizes in reserve, as often rolls had been scrapped as the result of making shift with faulty chills. The chief trouble met with in this class of work was cracking, sometimes vertically, sometimes round the barrel. Chilled rolls were used chiefly for rolling copper, brass, aluminium and other alloys.

Dealing with the more general castings which are essential for rolling-mill construction, Mr. Holberry mentioned first the housings, or standards, for carrying the rolls. This class of work was kept distinct from the casting of the rolls, and was nearly always done in a separate depart-

ment. It required all skilled labour. Such castings were made from about 8 cwt. up to 30 tons weight. No doubt the members were fully conversant with the methods of moulding such castings, but he would like to tell them how in his works they got over a difficulty in making a casting of 32 tons weight. In the shop where this was made they had only one crane that they could get to the job. Then their largest ladle held only about 26 tons, and their melting capacity from the two air-furnaces was only about 31 tons. They were fortunate, however, in having in the same shop two cupolas. They arranged to have about 5 tons from the cupola, and when this was melted it was poured into a bosh, holding about 15 tons, fixed over the down-runner. Then they tapped into a 10-ton ladle from the smallest of the air furnaces and, having put this into the bosh, tapped

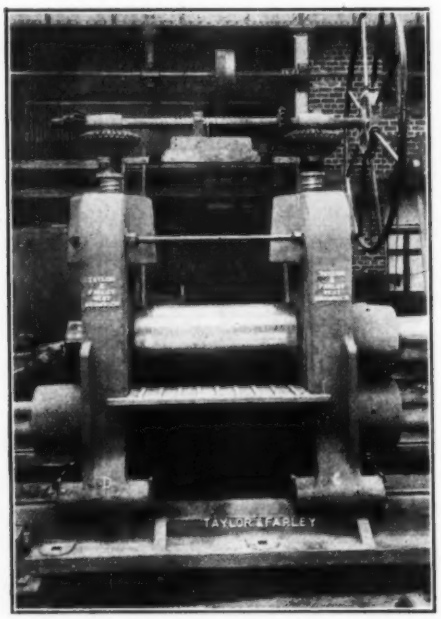


FIG. 6.—22-IN. ROUGHING MILL FOR ROLLING ZINC SHEETS.

from the larger furnace into the 26-ton ladle. When this was skimmed off and in position, the plug was drawn, and the cast proved quite satisfactory.

There were other castings required for rolling mills, such as chocks, spindles, coupling boxes, balance weights, etc., with which he would not weary them. But he would just briefly mention gear wheels and driving pinions. All wheels and pinions for the mills constructed by his firm were moulded on wheel machines, as by this method they ensured accuracy of pitch and a true wheel; whilst, as each tooth was made from the same block or pattern, they got a uniformity which could not be obtained either from a pull pattern or by putting them down with cores. Driving pinions were made by the same method, but these were very often made of steel, as they had to stand very severe shocks. This was particularly true of those used in blooming mills or any other type of two-high reversing mills. By moulding pinions on the machine they were able to make them with a minimum of clearance, thereby reducing the shock on the pinions when reversing.

Live-roller tracks formed another very important item in the construction of rolling-mill plant. These were used chiefly for conveying material from the rolls to where it was wanted for the next operation. They were arranged with skid gears, so that the load might be transferred from one direction to another without handling. These tracks consisted of cast-iron girder frames laid out to a certain width to suit the length of rollers they were required to carry. The rollers were made chiefly of cast iron, and were driven separately from the mill. In some mills these tracks were carried for long distances, and they had proved to be one of the best labour-saving devices introduced into rolling-mill construction.

Discussion.

MR. LEWIS, in proposing a vote of thanks to the Branch President for his address, referred to the remark made by Mr. Holberry regarding the 42-in. chilled roll. Anyone with experience in dealing with chilled rolls would endorse Mr. Holberry's statement.

MR. R. BUCHANAN, in seconding the vote of thanks, remarked that it was a long time since he had heard a paper or even a discussion with regard to the making of rolls. He could understand roll makers being somewhat reserved with regard to the amount of information they might be inclined to impart to their fellow foundrymen. At the same time there was a possibility of the roll makers losing considerable knowledge possessed by other members, and which would, if communicated, contribute to the progress of the industry. That was the disadvantage which always attended what he might call trade secrecy. Whether that secrecy in course of time might pass away with regard to roll-making he could not say. The malleable-iron trade was formerly in the same position, but its members had of late years been more ready to come forward and communicate their experiences, with the result that some of the difficulties which were experienced in the business had been removed. In some cases valuable information and suggestions had come from men who were not actually engaged in the malleable-iron trade. Therefore he would suggest to Mr. Holberry that there was just the possibility that the makers of rolls, whilst preserving their trade secrets, might be shutting themselves off from useful knowledge which they might obtain from others.

MR. HOLBERRY, in acknowledging the vote of thanks, said that he quite agreed with all that had been said by Mr. Buchanan. It was quite probable that foundrymen in various departments, and especially in the roll-making industry, were shutting themselves out from knowledge that was open to them. It was to meet this state of things that they had just formed a Research Association for the foundry trade. He hoped that the members of the Birmingham Branch would do all they could to obtain support for that Association. It was something that had been needed for a long time, and he hoped that every foundryman in the district would become a member of the Associa-

tion, as it would be a means of benefiting them not only from a scientific but also from a practical point of view. A Research Association, to be thoroughly successful, must have aid from the practical men. It was encouraging to know that experiments had been conducted in laboratories under an eminent scientific staff and that they had solved problems which otherwise would probably have remained unsolved. But practice in the workshop sometimes gave them altogether different results. Therefore it was necessary that the practical side should be well represented in the Association, so that they might be able to go to it not only with their scientific problems but also with their practical difficulties.

MR. BUCHANAN also referred to the formation of the Research Association, and, as a member of the Provisional Commitee which had brought the work to fruition, he assured the members that it was distinctly the aim of the Association that the practical man should have a good share in it. The work of the Association would be practically lost unless they got the practical men into it. Steps were being taken to ensure that the work of the Association should not become a laboratory matter and begin and end there. The results would be worked out in the practice of the workshops and foundries. Not only would the Association have a well-equipped laboratory, but it would accumulate information from all parts of the world, and these records would be most valuable to foundrymen. He did not say that the Association would be able to answer all their questions; in fact, some of them could ask questions which it would take many years to answer. But they might be certain that the Association would render accessible all the knowledge that might be available.

PROPER CARE OF CRUCIBLES. — It is pointed out by Mr. Edward F. Davis, in the American "Gas Age," while writing on the efficiency and low cost of gas fuel for brass melting, that the life of a crucible is almost as important as the cost of melting, and that anything which tends to shorten this life should be given serious consideration. In connection with a crucible, the most important thing in melting is to use a reducing flame, and to see that the crucible has been properly annealed and cared for prior to its use. Crucibles are free from moisture when they leave the manufacturers' kilns; but they absorb moisture very readily if not protected. If a damp crucible is used, and put directly into a hot furnace, or if it is heated too quickly, the moisture in it will be changed to steam so rapidly that small pieces of the crucible will be blown off bodily. This is known as "scalping"; and to prevent it, the crucible must be annealed by raising it from room temperature to about 225 deg. to 250 deg. Fahr.—this rise being gradual, so that the water may be driven off slowly. The crucible should then always be kept in a warm, dry place. Crucibles are also injured by packing them full of cold ingots or scrap, which expand as they are heated to the melting-point. The crucible does not expand as much as the metal, and strains may be set up which crack or weaken it. If crucibles are not allowed to cool down very much, but are kept hot continuously, so that there is less expansion and contraction, their life is lengthened. This is one reason for the longer life of crucibles in tilting than in pit furnaces. The continuous operation of crucible furnaces is unusual; but if the empty crucibles are promptly put back into the furnace, and allowed to cool gradually with it, the serious deterioration due to excessive expansion and contraction may be minimised.

The Institute of Metals.

The programme of the Institute of Metals, and of its various local sections, for the Session 1920-21, covers the activities of the Institute for a full twelve months, and never before has such a complete and detailed programme been issued so early in the Session.

Session 1920-21.

1920.

October 21.—H. W. BROWNSDON, M.Sc., Ph.D. Chairman's Address.

November 16.—Discussion upon "Hardness in Non-ferrous Alloys."

December 14.—W. R. BARCLAY, O.B.E. "Some War Experience in the Electro-deposition of Metals."

1921.

January 11.—ERNEST A. SMITH, A.R.S.M. "Segregation in Non-ferrous Alloys."

February 15.—O. F. HUDSON, D.Sc. "Bearing Metals."

March 22.—R. T. ROLFE. "Gun Metal."

April —.—Annual General Meeting.

The meetings are held in the Imperial Hotel, Temple Street, at 7.30 p.m.

Scottish Local Section.

1920.

October 27.—The Rt. Hon. LORD WEIR of Eastwood, P.C. (Member of Council). Address on "Some Notes on Foundries and Production."

November 9.—J. A. C. EDMISTON, "Fuel."

December 14.—Discussion on "Furnaces" (to be opened by Messrs. J. STIRLING and J. ARNOTT).

1921.

January 11.—S. E. FLACK "Rolling and Extrusion."

February 8.—G. H. BAILEY, D.Sc., Ph.D. "Aluminium, Production and Uses."

March 8.—Annual General Meeting. Address by MR. JAMES STEVEN (Vice-Chairman, Local Section).

The meetings are held in the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, at 8 p.m.

Sheffield Local Section.

1920.

October 15.—ERNEST A. SMITH. A.R.S.M. "The Development of Non-ferrous Research." (Chairman's Address.)

November 19.—"Electroplating." (Conjoint Meeting with the Faraday Society).

December 17.—J. KENT SMITH, O.B.E. "Some Alloys in the Foundry."

1921.

January 28.—Professor C. H. DESCH, D.Sc.. Ph.D. "60 : 40 Brass."

February 18.—F. ROGERS. D.Eng., B.A., M.Sc. "Cracking in Worked Brass and other Metals."

March 18.—W. ROSENHAIN, D.Sc., F.R.S. (Vice-President). "The Crystal Boundary."

April 15.—H. A. GREAVES. "A New Non-ferrous Electric Furnace."

The meetings are held in the Mappin Hall of the University of Sheffield, St. George's Square. at 7.30 p.m.

METAL ROTARY-PUMP VALVES.—Pump valves designed to eliminate cutting of the seat are a new product of the Norbom Engineering Company, Fifth and Ellis Avenues, Darby, Pa. The valve consists of an alloy body with a special soft metal face or lining, where it comes in contact with the seat. The under surface of the valve is cast with turbine veins, which cause it to rotate, thus to wear evenly the soft metal lining. The lining when worn can be renewed. The valves are made in sixteen sizes, ranging from 2 in. to 6 in. in diameter.

Loam Pattern for a Large-Diameter Double-Bend Pipe.

By C. Thomas.

The pipe under discussion in these notes is illustrated in Figs. 1 and 2. It will readily be appreciated that the skeleton irons and plates for such a pipe cannot be made in open-sand moulds. Details of a simple method of avoiding the use of top-part

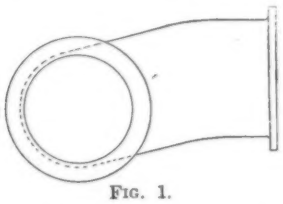


Fig. 1.

moulds for making this tackle and the complete moulding of this pipe in loam are given below.

Fig. 3 shows one-half of the core strickled up on a plate. The plate AB is made in the ordinary way, with the addition of the two bevel pieces cast on one end. These are made to follow the centre line of the pipe. The plates are cast open-sand, and the bevel pieces may be chipped to a template

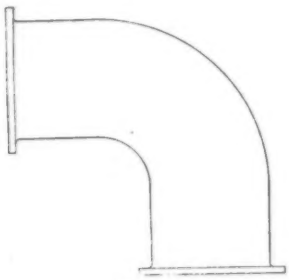
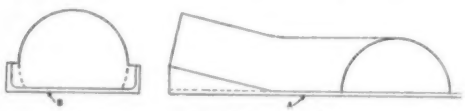


Fig. 2.

if they are not correct. The skeleton iron to carry the core and pattern is made to lay on the bottom of the plate, and care must be taken to make this plate narrow enough at the end where the bevel pieces are, as the diameter of the pipe is strickled on the top of the bevel pieces. When this half of the pattern is lifted off the plate, it will be necessary to rub off the loam from the top of the bevel



(a) Fig. 3. (b)

pieces to the plate, as shown by the dotted lines at A, Fig. 6. This can best be done when the other half of the pattern is placed in position, as this half is left the correct shape by the strickle.

The plate for this latter half is rather more trouble to make on account of the strickle having to work below the plate at one end. This plate must be made the shape as shown in Fig. 4, the width C being determined by laying the pipe out as at (a) and (b), Fig. 3. The width C must be narrow enough to allow the strickle to pass over it when working at its lowest place on the bevel pieces. These pieces cannot be cast on an open-sand plate. They are therefore fixed on after, and the plate is cast with the end reduced, as shown in Figs. 4 and 5, which also show the bevel piece used for this plate. This is an open-sand casting; the space D is made $\frac{3}{4}$ in. wider than C, and the

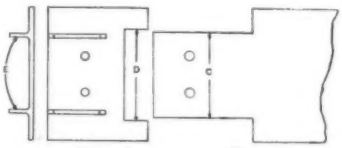


Fig. 5. Fig. 4.

brackets E have chipping pieces on the top. The total width of this piece is exactly the same as the plate. This bevel piece is shown in position at (a) and (b), Fig. 3, fastened to the main plate. It is advisable to have the necessary holes cast in the plate for bolting together rather on the large side.

(a) Fig. 6. (b)

The use of a washer plate will allow for adjustment in any direction. A template is used to try the bevel of this piece when bolted in position, and if the bevel is not correct it is an easy matter to take a bit off the brackets E until this is correct. As in the other half, care must be taken not to get the skeleton iron too wide at this end. The thickness and flanges are put on in the usual way.

NEW BLAST FURNACE AT NATAL, AUSTRALIA.—A new blast furnace is being erected at Natal, Newcastle, Australia. It is to be 14 ft. x 65 ft., on eight columns, with seven tuyeres. The hearth level is 9 ft. above the veldt, and the ground slopes down to the pig beds at a gradient of 1 in 100 ft. The foundation, 9 ft. deep, rests on solid sandstone. The iron ore to be used is mostly magnetic, and very rich, running between 60 and 65 per cent. metallic iron. It is at first intended to manufacture cast-iron pipe, and the management is in negotiation for machines working on the centrifugal principle.

CASE HARDENING IN CYANIDE.—As a result of their discovery that whereas pearlite due to carbon and pearlitic structure due to nitrogen are indistinguishable after picric or nitric acid etching, Stead's cupric reagent darkens the former very slightly but turns nitride black. Messrs. C. R. Brofby and S. B. Leiter, of the General Electric Company, are able to show that cyanided cases contain much nitrogenised material. They therefore conclude that absorption of nitrogen is responsible for the properties of articles case hardened in cyanide, as well as the carbon, which latter had formerly been thought the preponderating cause. If a bar containing 0.04 per cent. carbon be immersed four hours, the resulting surface will analyse only 0.33 per cent. carbon, yet it will easily resist a file. Quenched 30-point steel Brinells 207, but the cyanided bar is hard to file even after annealing. Further confirmation of the authors' ideas is found in the fact that if a cyanided case be ground off, the rod is still very brittle, and remains so after ordinary annealing.

Alloys of Carbon with Manganese, Nickel, Iron, Cobalt and Chromium.

A recent issue of "Forschungsarbeiten," published by the German Society of Engineers, contains a summary of the researches carried out by O. Ruff and his collaborators on the alloys of carbon with the elements manganese, nickel, iron, cobalt, and chromium. The results obtained in these investigations partly confirm and partly amplify the results obtained in previous investigations by this worker and his collaborators. The following is a short abstract of their communication, and the reader is referred to the originals for full details of the experiments and the results.

The results in each case have been plotted in the annexed five diagrams, and a comparison of these shows that certain points of abrupt divergence are common to all, a fact which the authors ascribe to the formation or dissociation of the various carbides. In the case of iron, manganese, and nickel, the point D is due to the presence of the carbides of iron, manganese, and nickel respectively, all of which are of the general type R_3C. Assuming that the percentages of free carbon in the molten metal at the temperatures in question are very small, the increase in the solubility with still higher temperatures can be explained by the formation of further carbides, which combine with more carbon than those of the type R_3C. For example, the authors believe that the discontinuity H in the iron-carbon diagram is due to the formation of a carbide of the type $Fe_{20}C$. In the chromium-carbide alloys a whole series of such discontinuities are to be seen, and these are suggested to correspond to compounds of the compositions as indicated in the diagram.

The investigators also state that no diamonds were formed on the cooling or gasification of the carbon solutions; in every case carbon separated in the form of graphite. In other respects the diagrams are self-explanatory.

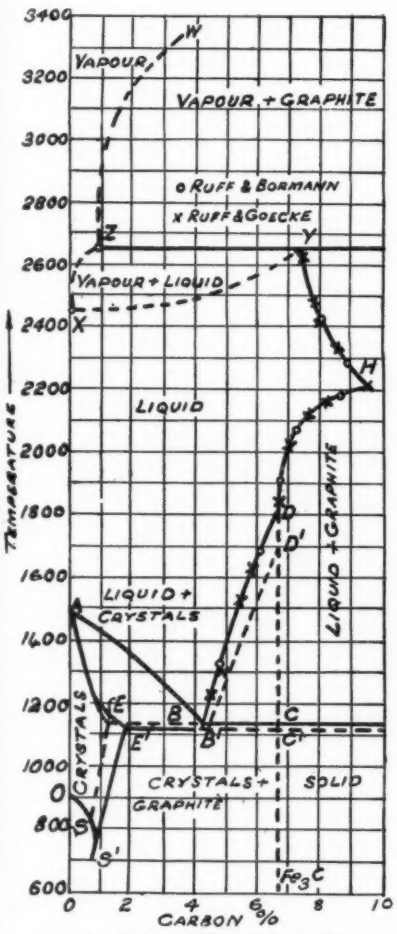


FIG. 1.—SYSTEM FeC (36 MM. HG.)

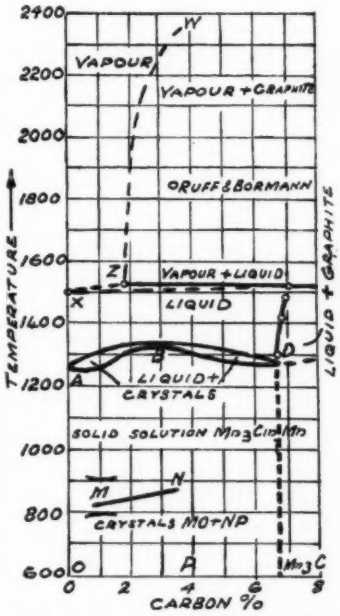


FIG. 2.—SYSTEM MnC (30 MM. HG.).

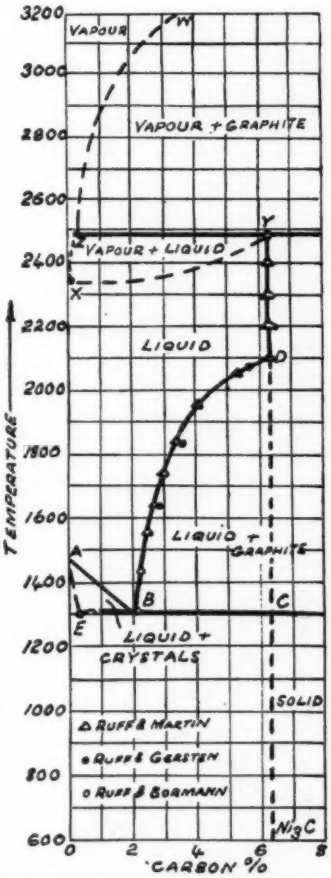


FIG. 3.—SYSTEM NiC (30 MM. HG.).

Acid Brittleness.

Mr. V. E. Hillman, Metallurgist, Crompton & Knowles' Loom Works, Worcester, Mass., writing in the "Edgar Allen News," states that when steel is subjected to a pickling operation, a phenomenon known as "acid brittleness" manifests itself. During the cleaning process the steel has a tendency to absorb the hydrogen gas that is liberated from the acid bath. Numerous metals possess the property, when cold, of absorbing several times their own volume of hydrogen gas. The ferrous alloys exhibit this property to a marked degree. The assimilation of the gas renders the steel extremely brittle; hence the term "acid brittleness."

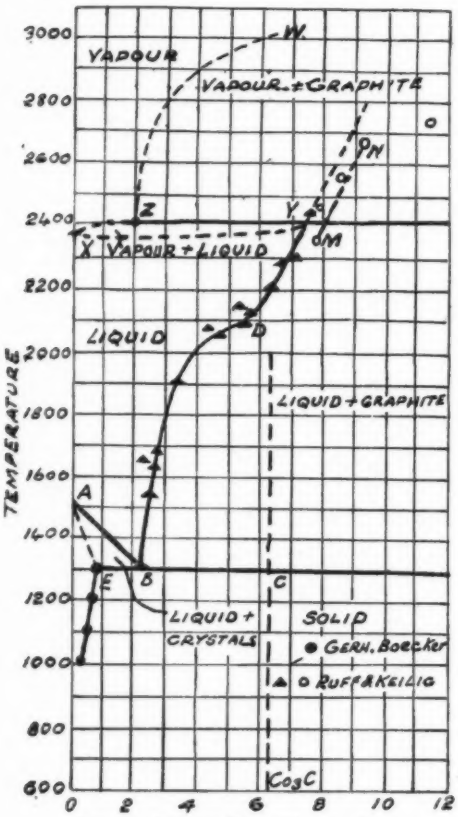


FIG. 5.—SYSTEM CoC (30 MM. HG.).

Bessemer stock and high-carbon stock in the "Natural" condition are decidedly susceptible to the detrimental efforts of such brittleness. Heat-treated parts also suffer from the lack of ductility as a result of pickling. A large manufacturing concern was sustaining an enormous amount of breakage in a certain type of flat spring, which was 10 in. long, 2 in. wide, and $\frac{1}{4}$ in. thick. A chemical analysis of the steel proved the quality of the metal. In addition, the pyrometer equipment in the heat-treating department was carefully checked. In brief, the steel manufacturer and the hardener were absolved from all blame for the trouble encountered. Further investigation, however, disclosed the fact that the springs were pickled for the purpose of removing the scale that formed during the hardening operation. By a process of elimination the pickling operation proved beyond doubt to be the primary cause of breakage. The acid method of cleaning the springs was discarded and the trouble ceased immediately.

The effect of the acid brittleness could have been removed in another manner, namely, beneficial results would have been obtained by heating the springs to 400 deg. F. for the purpose of driving off the hydrogen gas that was originally absorbed. Heating "acid brittle" stock is very effective in restoring the steel to its normal condition.

As a matter of interest, the chemical analysis of the steel and heat-treatment prescribed for the springs are subjoined below:—

	C.	— 0.80
	Mn.	— 0.35
	S.	— 0.04
	P.	— 0.04
	Hardened	— 1425 deg. F.
Drawn	— 900 deg. F.	— Saltpetre bath.

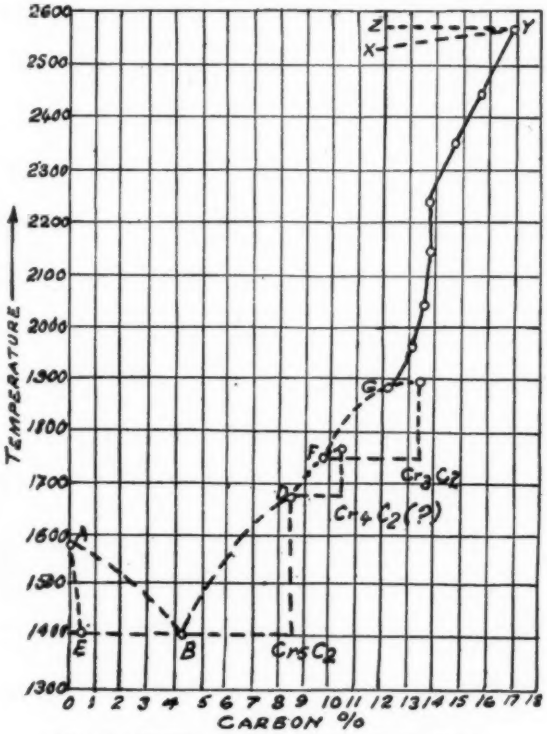


FIG. 5.—SYSTEM CHROME CARBON (30 MM. HG.).

CATALOGUE.—We have received from Messrs. Graphite Products, Limited, sole manufacturers of "Foliac" graphite specialities, a copy of their general catalogue. This is of considerable interest to users of graphite products, including graphite for lubrication, and amongst other things to the technical aspect of which a number of pages are devoted. The exceptional purity of foliac flake graphite, which is the basis of foliac graphite specialities, and which is regarded as one of the most important features of graphite for lubrication purposes, was referred to in a recent memorandum on "Solid Lubricants" by the Department of Scientific and Industrial Research, issued by H.M. Stationery Office.

Education in Relation to the Foundry Trade.

By B. Whiteley.

Part III.

The two previous sections of this article have dealt with the question of Education generally and with the Act of 1918 in particular, and have laid stress on the fact that education does not primarily consist in the acquisition of knowledge on the part of the pupil or in the giving of instruction by the teacher, but in the training of the faculties of mind and body in such fashion that the individual may be enabled to become a useful member of the society in which he lives, and may have developed in him those powers of initiative and self-expression which unfortunately at present seem to be the possession of comparatively few.

During the last few months, as evidenced by the number of papers given and the references made to the subject, the question of the education and training of the foundry apprentice is coming to the fore, and is exercising the minds of the leaders of the industry. Among the points made by various writers has been the low quality of the youth who enters the foundry. Considering that foundry practice calls for powers of initiative and craftsmanship equal to those required in any other branch of engineering, the fact that many youths who possess these qualities fight shy of the foundry should cause serious thought on the part of the general foundry management. If the prospects of the youth on entering the foundry do not appear so bright as in other branches of the engineering trade, if the conditions of labour in the foundry are such that they are repellent to the youth of good calibre, if the position of the foundry in comparison with the other sections of engineering is considered to be low, and if these are all capable of improvement by better organisation and management, as surely they are, it is the province of those who have authority in the trade that they should resolutely set themselves to the task of at least bringing the foundry into an equal position with the other sections of the engineering trade, and thus be able to claim and hold a fair proportion of the best brains of the community to their craft.

In connection with the same point of low quality in the entrants to the trade, grave dissatisfaction is expressed with the system of elementary education which produces so inefficient a result as would appear according to the experience of many foundry managers to be the case. It has already been pointed out that in elementary education a false start was made, and since writing the previous portions of this article, the following paragraph from a book by an ex-H.M. Inspector of Schools,* which has been brought to the notice of the writer, puts the case in a very forcible manner :—

"I could not but feel that far too much was being done for the children ; that they were being drilled into passivity and automatism ; that even in the more successful schools they were too often mere receptacles for information ; that they spent much of their time in school sitting still and waiting for orders; that initiative, individual effort, and spontaneous activity were systematically discouraged ; that the discipline which in some schools was so 'perfect' that when silence was enjoined you could hear a pin drop was an artificial veneer imposed on the children by Prussian methods, and so uncongenial to them that they were expected to misbehave themselves whenever the teacher's back was turned. The general impression left on my mind was that the atmosphere of the average elementary school was formal, mechanical, devitalising, charged with unreality and make believe."

"We were all—inspectors, managers and teachers—in bondage to a handful of officials at Whitehall, and our whole outlook on education was limited by bureaucratic ignorance and imbecility."

* In quest of an Ideal.—Mr. Edward Holmes.

This time of bondage is now over, but Education is still wandering in the wilderness, not yet having definitely entered the promised land, and the evil effects of this bondage are still with us. The avoidance of the mistakes of the past, and the granting of perfect freedom to those responsible for the educational side of the new continuation schools free from any form of bureaucratic control, will go far towards ensuring success in this new venture.

When one also considers the difference in treatment meted out by the responsible authorities in respect to the size of classes allowed in secondary and elementary schools, in the one case classes of thirty being considered the largest number a teacher can efficiently deal with, while in the other a teacher is held responsible for sixty children, and that at a younger period in their lives, is there any need to wonder if elementary education does not perform what is expected of it, or that a proportion of the children on leaving school are not what they ought to be?

The Committee of the Institution of British Foundrymen, which has had the better training of the foundry apprentice under consideration, reported that there was for all practical purposes no system of training for those youths in the foundry. Such a position is to say the least very unsatisfactory, in that it is largely a question of luck if a boy turns out to be a competent moulder rather than a partly trained workman, even though he may claim, by reason of his having "served his time," to be a moulder. The provision of means whereby a supply of well-trained and efficient craftsmen may be supplied is not simply a question for the foundry management. It is of equal or even of more vital importance to the workmen themselves. It is to the interest of the men that they should take part in the devising of some scheme which shall ensure a supply of skilled men to keep up and improve the traditions of the foundry in respect to the quality of its products ; and surely the time is now opportune for the trade societies to which the bulk of present day workmen belong to widen their vision and to take a share in the development of some plan whereby the future entrants to the trade should be definitely trained to have a more certain and accurate knowledge of the principles and methods underlying their work. The demands made upon the foundry by the other branches of engineering are becoming year by year increasingly higher, and such high class work can only be properly produced by those who are trained to understand the principles as well as the practice of the operations of moulding. The suggestion is made that in the interest of all concerned in foundry practice, but particularly in the interests of those who will become the foundrymen of the future, the workmen's societies should regard the matter of the training of the foundry apprentice as one of the most vital of their activities, and take such part in the formation of a live scheme of training as will result in the future of the foundry being brighter than its past. In addition to the fact that a highly-trained and intelligent workman is able to produce better finished work—other things being equal—than one who has not received such training, it is certain that the higher mental development which comes with proper training, by giving greater appreciation of the principles underlying all the processes of the work, and the possibility of improving on methods and processes, will reduce the drudgery of much of the work and give it a living interest to the one engaged on it. Such scheme of training would have the double effect of raising the standing of the individual workman, and also the status of the trade, bringing it into prominence as a craft that requires initiative and intelligence of no low order. There are certainly many difficulties in the way of realising such a scheme of training for future foundry-

men, but the whole history of the foundry is the story of difficulties overcome, and the provision of the means to ensure a thoughtful intelligent and skillful type of man able to carry on the work of the foundry to a higher plano of excellence than it has previously reached, and to give the foundry its rightful place in the great engineering family is not unworthy of a determined effort to overcome difficulties, and not the least benefit which would accrue would be the moral effect of such an attempt.

For education to succeed in the real uplift of the nation, it must not only open men's eyes to a wider vision, but it must carry in its train a wider tolerance, and a determination that righteousness and justice shall be the foundation upon which men shall build their lives.

Method for Determining Cupola Charges.

By H. L. Campbell.

The important influence of silicon contents on the properties of cast-iron has led to the practice of using this element as the determining factor in calculating the metal mixtures. In order to facilitate the rapid and accurate determination of the charges for cast-iron, charts may be prepared from which the relative quantities of the different metals making up the charges may be read directly.

The chart illustrated in Fig. 1 has been prepared by the writer, and is reproduced here from a recent issue of "The Foundry World."

The analysis of the proportions of the mix and the

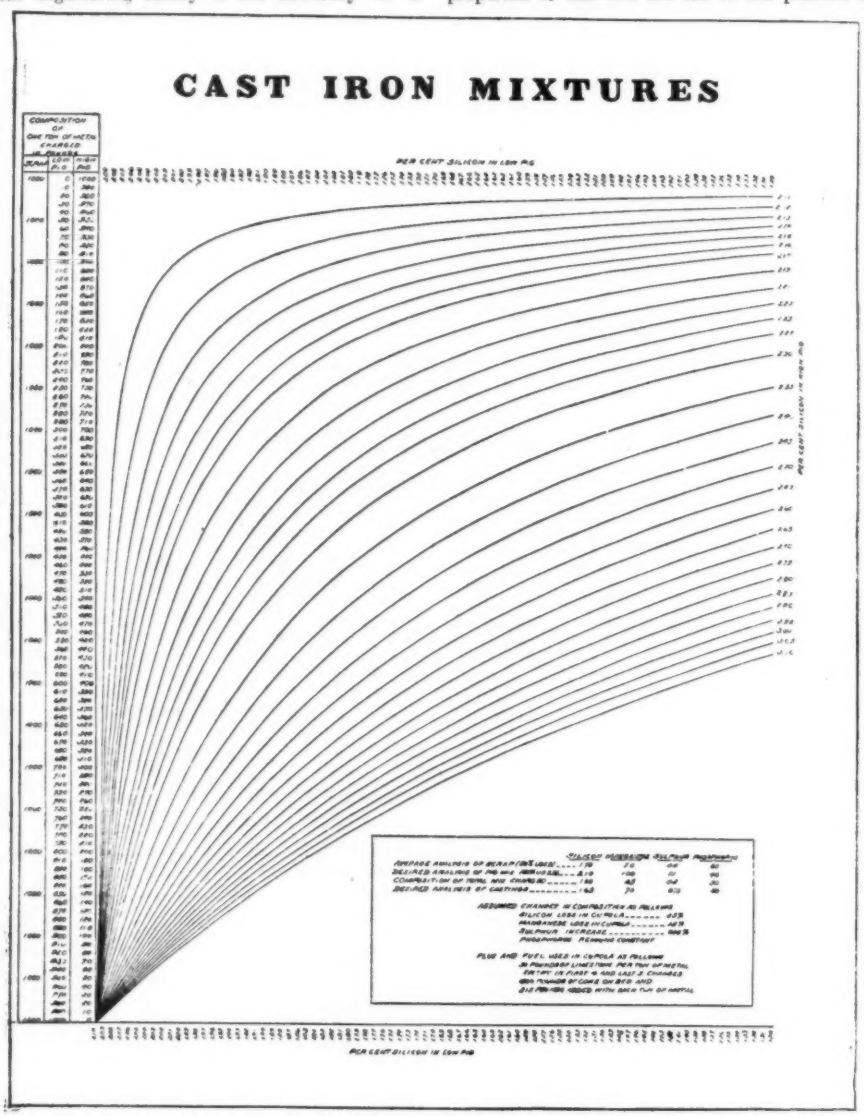


Fig. 1.—Chart for Determining Cast-iron Mixtures.

resulting metal are given on the chart. In this case, the pig mixture must contain 2.10 per cent. silicon. Using this figure at the origin, decreasing percentage of silicon are laid off on the base line towards the right. On the left side of the chart are arranged in columns the scrap and pig for every possible mixture. Each lot of high silicon pig is represented by a curve. In order to find the correct mixture of any two cars of pig which will produce the desired composition in the castings, a line is drawn vertically from a point on the base line, which corresponds to the silicon in the low silicon pig, to the intersection of the curve which represents the per cent. silicon in the high silicon pig; and from this point of intersection a horizontal line is drawn to the left which will indicate the proper weights of scrap, low pig, and high pig for each charge.

If it is desired to use three or more lots of pig to a charge, the mix for any two lots must be found first and then any proportion of the different mixes may be added up to give the full charge.

As an example: Suppose the scrap analyses 1.70 per cent. in silicon, and there are two cars of pig on hand containing 1.80 per cent. and 2.30 per cent silicon. If in addition to the two cars of pig there is in the yard a small pile of 440 lbs. of pig containing 2.14 per cent. in silicon, then the proper charge may be found as follows:—It is shown on the chart that 120 lbs. of low silicon (1.80 per cent.) pig must be mixed with 880 lbs. of high silicon (2.14 per cent.) pig, or that one-half of this mix will use up all of the 2.14 per cent. silicon pig. Therefore, one-half of this mix must be added to one-half of the mix from the two cars in order to give the total charge, which will consist of 1,000 lbs. of scrap, 250 lbs of 1.80 per cent. silicon pig from car, 300 lbs. of 2.30 per cent. silicon pig iron car, and 440 lbs. of pig from yard.

When the melting practice has been established, and a chart has been prepared, all possible mixtures may be taken directly from the chart. Slight variations in the analysis of scrap will produce only small changes in the composition of the resulting metal. Foundries that do not have laboratory facilities may use the analysis made at the furnace of each car of pig-iron received. When a chart is furnished to meet the needs of any foundry, it may be used indefinitely and to great advantage.

Electric Smelting of Iron Ore in Norway.

The fact that Norway, while rich in iron ore, imports between 300,000 and 400,000 tons of iron and steel annually has often been the subject of comment. Native expert opinion has frequently asserted that, given suitable power supply, the country could produce iron and steel in quantities sufficient to meet its own requirements. Mr. Ragnvald Blakstad, who owns ironworks in the Tyssedal, Norway, has recently asserted that it would be possible to produce from 4,000,000 to 5,000,000 tons of iron-ore concentrates annually, and, by the use of hydro-electric power, work up the ore into iron and steel products ample in amount to meet the native demand. Mr. Blakstad has himself installed electric furnaces for the smelting of concentrates, but states that he is unable to obtain permission to carry on the work. If the water powers of the country were developed in an adequate manner, foreign supplies of fuel would become superfluous.

Two brothers by the name of Stiig, employed at the Trollhätten power plant in Sweden, claim to have invented a process for the electrical smelting of iron ore whereby only about 350 kg. of coke would be required for the manufacture of one metric ton of pig-iron. The Sima Company, of Christiania, became interested in the proposition and contracted with the inventors to continue their experiments for the further development of their process. Within the past year the company has succeeded in interesting the Norwegian Government in making a subvention of 500,000 kr. (say £27,750) to assist in the erection of furnaces for the practical application of the Stiig process. The terms of the subvention require that 700,000 kr. (under £40,000) be raised independently of the Government. The process mentioned has been carefully examined by a committee of experts appointed by the Norsk Investment Company, which is handling the financial side of the enterprise; the Committee reported very favourably. The Sima Company proposed to build immediately a large plant, including a rolling mill, but the Committee declined to recommend so ambitious a project before the process had been thoroughly tested. The Government has also provided for a subvention enterprise at Narvik, this being known as the Narvik Staal og Valseverk (Narvik Steelworks and Rolling Mills). It is understood that the process of smelting iron proposed by this company is identical with the Stiig process. The Government has granted a subvention of 16,000,000 kr. (about £90,000) to the Narvik project.

Brass Foundry Fluxes.

At the recent autumn meetings of the American Foundrymen's Association at Columbus, Ohio, Messrs. Hill, Thomas, and Vietz read a Paper describing results of an investigation of brass foundry fluxes.

As a result of their studies they are forced to the conclusion that the real action of such fluxes is physical in nature. It may be largely mechanical. That is, the rapid evaporation of the flux at the points of contact with the surface film may mechanically break the film, allowing the molten particles to unite. The flux may penetrate through the film and react with the metal below, giving a volatile substance which disrupts the film. Since the fluxes themselves and the volatile products, possibly by a chemical reaction, are of about the same volatility, this explanation does not appear to hold.

The costs and the detailed system of the treatment of brass foundry refuse in the reclaiming plant of the Ohio Brass Company is dealt with by Messrs. Wolf and Anderson. F. L. Wolf and his collaborator, A. A. Gubb also contribute a further interesting Paper on the laboratory testing of sands, cores, and core binders, in which they endeavour to establish a systematic scheme for the investigation of the much discussed properties of these materials.

GRAPHITE IN CANADA.—The Department of Mines, Canada, in a report published by the "Canadian Mining Journal," discusses the Canadian production of graphite and the properties and uses of this mineral. In order of present importance, the principal uses of natural graphite are in the manufacture of crucibles, lubricants, pencils, foundry facing, paints, stove polish, and dry batteries, while small amounts are also used in electrotyping and as a boiler scale preventive. According to a competent authority, the world's production of natural graphite is divided among the more important of the industries mentioned above, approximately as follows:—Crucibles, 75 per cent.; lubricants, 10 per cent.; pencils, 7 per cent.; foundry facing and stove polish, 5 per cent.; paints, 3 per cent. It is obviously impossible to ascertain the proportions with strict accuracy, and the consumption of several of the minor industries will doubtless reduce the above percentages slightly, without, however, materially altering the ratio. The Report goes very fully into the manufacture and uses of graphite crucibles, but mentions that the growing use of electric furnaces is displacing the crucible process.

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NOTES AND COMMENTS.

Fuel Economy in the Blast Furnace.

Blast-furnace fuel problems have always been of especial interest to foundrymen on account of the somewhat similar nature of the cupola fuel problems. Whilst in many cases the principles which are possible of application to blast-furnace practice, largely on account of its huge size and continuous character of its operation, cannot be applied to the foundry supola, a consideration of the theory underlying these principles is often advantageous in enabling the foundryman to understand the vagaries of his cupola working.

Superficially the reasons for the increased fuel economy and increased rate of production in the blast furnace by the use of hot blast introduced by Neilson in about the year 1828 have always appeared straightforward, and it comes as a surprise to learn from the analysis of the figures published by Mr. W. W. Hollings in his recent Paper before the Iron and Steel Institute that the influence of hot blast is not so simple as would appear.

Mr. Hollings pointed out in a specific instance quoted by Sir W. Lowthian Bell, that an increase in the temperature of the air from 60 to 450 deg. F. reduced the coke consumption from 60 to 38 cwt. per ton of pig-iron, a saving of 36.66 per cent. Now per ton unit of carbon burnt in the furnace this increase in the blast temperature would mean the addition of, roughly, 300 calories to the hearth, an amount of heat equivalent to 2.43 cwt. of carbon burnt to carbon monoxide before the tuyeres, or a saving of only 12.15 per cent.

The introduction of a method of abstracting the moisture from the blast by Gayley in about 1904, now well known as Gayley's Dry Blast, led to experiments being conducted by the Brymbo Steel Company with a view to effecting a considerable saving in fuel by this method. The results published in Gayley's original account of drying the blast were apparently very satisfactory. By reducing the moisture content from 5.56 to 1.75 grains, or a reduction of 3.9 grains per cubic ft., and, incidentally, raising the temperature of the blast from 382 deg. to 465 deg. C., he reduced his coke consumption from 2,147 to 1,726 lbs. per ton of pig-iron a saving of 19.61 per cent. The moisture content of the atmosphere at Brymbo was found to be just over 3 grains per cubic ft., and no difficulty was anticipated in reducing it to 1 grain. It was assumed that with such a reduction an economy of not less than 10 per cent. should be obtainable. As a matter of fact, when the plant was installed the actual saving was only 3.34 per cent.

To explain these phenomena, Mr. Hollings advances the theory that any variation in the amount of heat supplied to the blast furnace involves a secondary and complementary series of changes in the amount of heat produced and absorbed internally. The proportion borne to the initial variation by these complementary internal changes constitutes the ratio of an infinite geometric series having the primary variation as its first term. For example, suppose the net increment of heat in the furnace directly resulting from the addition of 200 calories amounts to 144 calories, then these 144 calories will in turn be responsible for a further addition of 144/200 of 144, and so on. If a represents the initial variation and r the proportion borne to it by its complementary internal change, the total variation will be the sum of the geometric series, or $a\ (1-r)$, which with $a = 200$ and $r = 0.72$ will amount to 714.3 calories; and this will be the ultimate calorific effect on the furnace caused by the addition of 200 calories.

Application of the theory to the figures of Gayley's original trial gives the theoretical saving as 21.92 per cent., of which 11.34 per cent. would be due to the drying and 10.55 per cent. to the increase in blast

temperature. At Brymbo for a reduction of moisture from 3.1 to 1.3 grain per cubic ft. the theoretical saving was only 2.18 per cent., against 3.34 per cent. actually obtained. Here the drying of the air was slightly offset by a diminution in its temperature. In both cases the theoretical results would have been brought more nearly into line with the practical had it been possible to include tuyere water losses.

Mr. Hollings considers on this basis that for countries of such a low average absolute moisture as England it does not pay to instal dry blast, and that crushing the materials of the charge to a uniform size may be expected to result in a considerable economy of fuel per ton of pig-iron. In a like manner for a small percentage increase in oxygen the process of blowing oxygen-enriched air is not likely to produce any appreciable saving in fuel.

In other words, the conclusions of Mr. Hollings resolve themselves into the fact that the uniform grading of the components of the charge is the most likely way of effecting economy in blast-furnace working. For the foundry, cupola foundrymen will all agree that the same conditions are necessary to secure economy and efficient melting.

Recrystallisation.

The process of recrystallisation in metals and alloys is claiming the attention of metallurgists and engineers, and the results of Messrs. Carpenter and Elam's investigation have been published in an extensive Paper before the recent meeting of the Institute of Metals. The following notes taken from "Zeitschrift des Vereines Deutscher Ingenieure" or of considerable interest.

Under favourable conditions, especially at high temperatures, the grains or crystals of metals and alloys may undergo certain transformations. The crystals may grow in size and generally change their form. These phenomena are described as recrystallisation, and are of considerable commercial importance in that the change may or may not create a dangerous condition in the metal or alloy according to the conditions under which the change takes place.

As an example, the case of sheet zinc was cited which apparently was the source of considerable trouble due to symptoms of recrystallisation which set in even at normal temperature. On this account the value of zinc was lowered to an extraordinary degree.

Although the phenomena of recrystallisation have been known for a long time, very little is known regarding the mechanism of the changes or the nature of the laws governing them.

Dr. G. Massing has now attempted to systematically investigate the two processes of which recrystallisation is alleged to consist. These processes are the amalgamation of the smaller crystal grains to form larger ones and the direct formation of new grains as distinct form the boundary migration of smaller grains. This latter Dr. Massing designates as "nucleus-formation." The experiments were conducted on rolled tin and zinc.

It has been established that no nucleus formation occurs in the first phase of recrystallisation of these metals, but that a nucleus structure is very quickly created according to the extent of the preliminary work put on the metal. In their development these structures follow a law defined by Crochralsky. If the tin or zinc after having been rolled is subjected to some other kind of deformation; for example, if it is bent this leads to far-reaching changes in the character of the recrystallisation. At a definite temperature nucleus-formation takes place; the new nuclei grow with great rapidity and end in the formation of extraordinarily large crystals by absorbing the existing structure

These phenomena have been repeatedly described in the case of most metals. In the case of iron it has not yet been definitely proved that there is any connection between the recrystallisation and the two kinds of deformation. In zinc and tin further experiments showed that in the case of tin a nucleus formation could only be observed after the second deformation, whereas in zinc it occurred after the normal rolling at temperatures of 150 deg. to 200 deg. C.

In connection with the observations made, Dr. Massing examined the question as to whether the observed phenomenon allowed one to establish a general theory of cold stretching. He came to the conclusion that the assumption of a re-arrangement (verlagerung) of the inner crystal structure during cold working which has been particularly developed by Crochralsky cannot be avoided. The experiments are being continued with other metals.

British Grey and Malleable Cast-Iron Research

In our issue of December last year we commented upon the need for research in relation to the ironfounding industries, and, judging by the attendance at the recent inaugural meeting of the British Grey and Malleable Cast-Iron Research Association, the belief in this need is widespread. The proceedings of this meeting are fully reported elsewhere in this issue. The proposed scheme was explained in detail from the point of view of the Government Department for Scientific and Industrial Research, and a resolution was passed that a Research Association be formed. With this resolution we are in perfect agreement, and wish the Association every success.

It would be superfluous to emphasise the need for research in the grey and malleable cast-iron industry for this was ably done by several speakers at the inaugural meeting, and, further, every thinking foundryman knows it quite well. It is, however, necessary to emphasise the point carefully, made by both Sir Frank Heath and Dr. Aitchison, that immediate results should not be anticipated, but that research and not results should be the chief aim. It follows, as surely as night follows day, that, if serious research is properly and systematically undertaken, the results will in the end be obtained. This aspect of the question is often very difficult for the average ironfounder—who, after all, is primarily a business man—to understand, and cannot be over-emphasised. Of course, the success of this or any similar organisation depends upon the Research Director, whose business acumen, scientific qualifications, and clear insight into the problems to be solved, are of primary importance.

We should like, further, to draw attention to the suggestion of Sir Frank Heath, that Labour might be represented on the Advisory Council of the Association. We are heartily in agreement with this suggestion from many points of view, particularly in an Association belonging to the ironfounding industry, where so much of the success is due entirely to the individual skill of the workman. We trust that this point will not be overlooked.

In conclusion, we must congratulate the Institution of British Foundrymen, at whose instigation, and as a result of whose efforts, the Association has been brought into being. All those workers who have carried out the pioneer work in the formation of the Association will join with Mr. Riddell in bearing testimony to the untiring efforts and enthusiasm of Mr. Vickers, the provisional hon. secretary.

THE value to manufacturers of systematised and indexed records of all available metallurgical information in conjunction with full records of works processes and investigations was strongly emphasised by Dr. H. W. Brownsdon (King's Norton Metal Company) in his address as chairman of the Birmingham Local Section of the Institute of Metals on October 12.

New Steel Foundry at Washington Ironworks.

Messrs. Thomas Cook, Sons & Company, Limited, Washington, Durham, have been making steel castings for upwards of 70 years, first by the crucible, later by the Siemens, and finally by the Troepenas process, and with a view to bring their plant fairly into line with modern practice, and provide for an increase in business, they decided to dismantle the old and build an entirely new foundry, which in the light of present practice could be laid out to ensure a more economical production than could possibly be attained by making additions to the existing plant.

The new foundry is covered by two bays. The melting plant, which is disposed on one side of the stocking ground, comprises a cupola of 10 tons per hour capacity; the charging platform is served by an electric hoist, but material can also be loaded to the platform by a 5-ton travelling crane, which serves the stocking ground; the pig-iron, scrap, etc., being handled by an Allen West magnet.

For the time being coke is stored on the ground level, but now that producer gas has been abandoned as a heating fuel, the producers which are installed in a pit adjacent to the foundry will be dismantled, and the pit converted into a storage bunker for coke, from which the coke will be delivered by a bucket elevator direct to the charging platform.

FIG. 1.—VIEW IN MAIN BAY LOOKING TOWARDS MELTING PLANT. MESSRS. THOMAS COOK, SONS & COMPANY.

FIG. 2.—SMALL-CASTING BAY. MESSRS. THOMAS COOK, SONS & COMPANY.

The blower house contains two Roots blowers, which are driven off line shafting by a Phœnix 100 h.p. motor; these blowers, however, are to be displaced by a Keith Blackman fan.

In the smaller foundry bay, which is served by a 2-ton hand and a 3-ton electric crane by the Harland Engineering Company, is a Troepenas converter of 25 cwts. capacity, with which from 8 to 9 heats are obtained per day.

The casting-ladles are heated by hot blast, and the drying stove is coke-fired under pressure. The whole of the moulds in this bay are hand rammed.

The large bay, the floor of which is served by a 20-ton Holt and Willetts contains a Troepenas converter of 8 tons per hour capacity, whilst adjacent to it is a 9 hole crucible furnace used for melting additions and also for making manganese steels. The molten metal is run from the cupola direct to the converters. The bay contains two jolt ramming machines by John Macdonald & Son, Limited, Glasgow. There are two coal-fired annealing stoves, each of which will take a charge of 40 tons of castings. The stoves are provided with doors on either side, and are served by bogies travelling on a track. The castings are loaded and charged to the ovens from the foundry floor, and after treatment are removed through the second set of doors into the fettling shop.

FIG. 3.—MAIN CASTING BAY. MESSRS. THOMAS COOK, SONS & COMPANY.

The core shop, with two nests of drying stoves, is contained in an annexe. Quasi-Arc welding and oxy-acetylene cutting-off plants are also installed. Foundry debris is loaded into a tub which travels on a track running at right angles to the bays, by which the dirt is delivered to an adjacent clay pit.

At one end of the foundry is a well arranged laboratory, and above this the steelworks manager's office.

HUME PIPES.—The concrete pipes made by the Hume Pipe Company of South Africa, Limited, are now much in demand all over South Africa as a substitute for iron pipes up to 8 ft. in diameter. The factory is at Germiston, and the company is hardly in need of moulders accustomed to working in concrete and cement. We notice that some firms are having o'd sheet and light iron pipes lined with concrete by the Hume Company, which effects a considerable saving compared with new pipes.

Determination of Carbon in Iron and its Alloys.

At the general meeting of the American Electrochemical Society held in April, two Papers dealing with the determination of carbon in iron and its alloys were presented.

In the first Paper, Mr. T. D. Yensen pointed out that in estimating carbon in irons where the carbon content was less than 0.1 per cent. established methods are unsuitable and the greatest accuracy attainable is 0.01 per cent. The chief sources of error are in contamination of the sample with oil, grease, etc., admission of CO or CO_2 in opening the combustion tube, incomplete absorption of CO_2 in the potash bulb, inaccuracy in weighing the potash bulb, and the leaving of carbon in the sample.

Those sources of error can be eliminated to a large extent by boiling the sample in ether prior to placing it in the combustion boat, taking special precautions in preparing the combustion boat and tube, carrying out the analysis in the three following stages:—(1) Evacuating the sample cold, (2) heating to 600 deg. C. in vacuo, (3) heating to 1,000 deg. C. or over in oxygen and finally by freezing out the CO_2 with liquid air and allowing it to expand into an unknown volume and measuring the increase in pressure.

The carrying out of the combustion in three stages differentiates between the carbon admitted to the tube in introducing the sample, the carbon present in the form of occluded gas, and the combined carbon. In general, adopting this method of analysis consistent results are obtained with an accuracy of 0.0001 per cent.

The second Paper, by Mr. C. J. Rottmann, deals with the determination of carbon in ferro-alloys, and gives a description of the furnaces, absorbing apparatus, and methods of operation by which an accuracy of 0.002 per cent. can be attained. Cleaning the sample with ether is recommended, heating at 450 deg. C. for several hours, then burning in oxygen at 1,000-1,100 deg. C. An accurate absorption bulb, which is light, compact, and easily manipulated, is fully described. The best type of furnace to use is a michrome furnace or a carbon resistance furnace, although with the latter type it is necessary to protect the silica combustion-tube with alundum to prevent penetration of external carbon.

The New Alloy of Magnesium.

By E. J. Jenkins.*

The "Iron Age" announces a new alloy, manufactured by the Dow Chemical Company, Midland, Mich., and called Dow metal, is the lightest metal known which is adapted to commercial uses. It contains over 90 per cent. of metallic magnesium, which distinguishes it from all other light alloys now on the market. Others are composed largely of aluminum and contain magnesium, if at all, in small amounts. Magnesium is the lightest metal which, at the same time, has the tensile strength and the physical properies making it suitable for engineering uses.

This new alloy has been brought to the attention of engineers within the last year. Dow metal is one-fourth the weight of cast-iron and all aluminum and aluminum alloys are 50 per cent. heavier, or it could be said, magnesium is one-third lighter than aluminum. A comparison of the three main piston materials, as to weight in ounces per cubic inch, is as follows:—

	Oz. per Cu. In.
Dow metal	1.04
Lynite	1.56
Cast iron	4.16

When the foreign supplies were cut off early in the war, the manufacture of metallic magnesium was undertaken by the Dow Chemical Company, there being unlimited amounts of the raw material in the brine pumped from its numerous wells, from which many other chemical products were manufactured. Among these manufactured products is the salt, magnesium chloride, which after suitable preparation is used for the manufacture of metallic magnesium. The process employed is electrolytic in which a heavy direct electric current is passed through a molten salt bath, maintained at a red heat until it is decomposed by the current and the metallic magnesium is formed which, on account of its extreme lightness, rises to the top, floats on the surface of the molten bath and is skimmed off from time to time.

Appreciating the fact that in the past the demand for magnesium was limited, because no alloy of it had been discovered which possessed the mechanical properties necessary for its use in practical construction of the parts in automobile and aircraft production where sufficient tensile strength with the other necessary qualities was needed, the Dow Chemical Company established a research department and for the last five years or more this work has been carried on. Under the direction of Dr. W. R. Veazey, Case School of Applied Science, Cleveland, the chemists to make the first metallic magnesium at this plant were Messrs. Stafford, Collings, Burdick and Gann, and the alloying of this metal was then carried on by Veazey and Burdick until, after many tests, the present Dow metal alloy was obtained.

The main use found thus far for this alloy has been in the manufacture of pistons for automobiles and aeroplanes, as well as motor boats. Possessing a tensile strength of from 22,000 to 25,000 lb. per sq. in it is also the lightest material used for such purpose, besides having no abrasive or scoring action on cast-iron cylinders and having approximately the same coefficient of expansion as other light piston alloys. Dow metal differs from aluminum as to the expansion under heat in a motor in that there is no permanent growth or set at these temperatures. Recent tests have shown that with 21 successive heats made of Dow metal for two hours each and for 0 to 800 deg. Fahr. the permanent growth is so minute that it cannot be detected with a micrometer.

* Dow Metal Department, Dow Chemical Co., Midland, Mich.

In machining no cutting compound is used and with the lathe running at the highest speed, there is no tearing of the metal and no dulling of the tool by hard spots.

The following table gives some of the more important physical properties—

Specific gravity	1.79
Tensile strength, lb. per sq. in....	22,000 to 25,000
Yield point, lb. per sq. in. ...	12,000 to 14,000
Compressive strength, lb. per sq in.	45,000
Elongation, 2 in., per cent.	3.5
Reduction in area, per cent	3.5
Modulus of elasticity	9,000,000
Brinell hardness	55 to 75

Where Dow metal is re-worked or rolled, drawn, drop forged or heat treated, the tensile strength is increased at each operation. In heat treating, sand castings are increased from 22,000 to 25,000 up to 30,000 lb. per sq. in. or more, without causing any appreciable change in the yield point, while the elongation and reduction in area are increased to 6 per cent. In drop forging, the tensile strength is increased to 50,000 lb. per sq. in. and the Brinell hardness rises to 70 or better.

"The heat conductivity is 0.295, as compared with 1,000 for pure copper and 0.108 for cast iron. The coefficient of linear expansion, over a range from 0 to 800 deg. Fahr. is 0.000028. This coefficient appears to be high for a material to be used in pistons. However, this expansion is not accompanied by any permanent growth. In one test, a bar was submitted to 21 heatings of two hours each at 800 deg. Fah., and it showed an increase in length of only 0.0003 in. per inch, an amount so small as not to be detected with the micrometer. In practice, pistons are fitted to the same clearances in the cylinder as are commonly given to aluminum pistons and, fitted in this manner, they have given entirely satisfactory service under all conditions."

The first real test of Dow metal pistons was made by the Dow Chemical Co. in its Ford roadster over a year ago. The car has been in constant service since that time and now has a mileage of over 20,000 miles and is still giving good service. At one time on a 5,000-mile test, the gas consumption was 23¼ miles per gal. and the oil at the rate of one quart for each 100 miles. At the conclusion of the test, the piston showed very little wear and the cylinder none. Since the original test set of pistons were put in, many additional sets have been installed by the company in its own test cars and by a large number of private car owners. The sound of the Ford motor with Dow metal pistons is hardly recognisable. Recent tests in a plant of a well-known manufacturer of motors show that these motors developed six horse power more with the Dow metal pistons than they had ever developed before with any other material. In spite of the rather ample clearances with which these pistons are installed in the cylinder, no case of oil pumping has yet been recorded and the objectionable piston slap is absent.

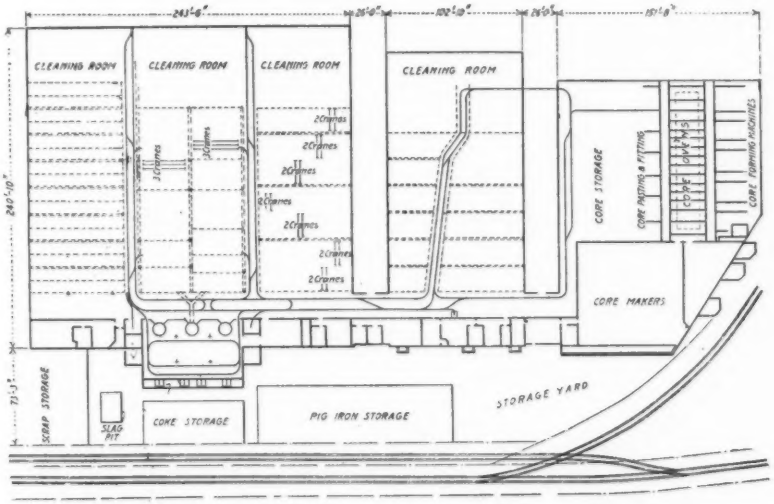
IMPERIAL MINERAL RESOURCES BUREAU.—We have received notice of a series of publications on the mineral and metal industries and resources of the British Empire and foreign countries, which is being published by H.M. Stationery Office for the Imperial Mineral Resources Bureau, and which, when complete, will constitute a mineral statistical digest in respect of all commercial minerals for the war period for the whole world. The series provides, in respect of each mineral or metal, an up-to-date authoritative synopsis of the information available as to the mineral industry for the period under review. Each part on a particular mineral or metal is issued as soon as it is completed, as it is considered a more useful purpose will be served by so doing than by waiting for the completion of the whole digest. The digest will be kept up-to-date year by year.

A Modern American Foundry Equipment.

A recent issue of the "Iron Age" describes the recently-erected foundries of the Hercules Gas Engine Company, Evansville, Ind., U.S.A.

This company are engaged in the manufacture of small engines for farm use, ranging in size from 1½ to 12½ h.p., and the new foundry described was designed to make the castings for about 120,000 engines per annum. Mass production at a minimum of cost in materials, time, and labour was the aim in planning and equipping the plant. As in the case with any industrial foundry as distinct from a jobbing shop, the special character of the work lends itself to a high degree of development in labour-saving devices and methods.

The general lay-out of the foundry is shown in Fig. 1. The stock yard, which is located adjacent to one of the long sides of the foundry, consists of a raised concrete platform to facilitate the handling of material arriving in box cars. The stock yard is divided into scrap storage, coke storage, and a pig-iron storage, which is sub-divided into wooden bins, fronting on aisles leading from the car doors to a connecting aisle adjacent to the foundry. Weighing apparatus is located in each pig-iron aisle in order that the iron may be weighed on the spot before taking to the charging floor. It is intended to instal a gravity conveyor for transferring the pig-iron direct from the cars to the storage bins.


CLEANING ROOM
CLEANING ROOM
CLEANING ROOM
CLEANING ROOM
CORE STORAGE
CORE MAKERS
CORE MAKERS
CORE MAKERS

serving the core benches. Thus a given core rack can be moved directly from the core department into the proper oven without disturbing its contents. It will be noted that the springs on the rack eliminate such jars and jolts as might otherwise injure the cores in transit. The ovens are regulated by the recording pyrometers manufactured by the Brown Instrument Company, Philadelphia, and are coke-fired from a subway below.

The foundry is equipped with three 96-in. Whiting cupolas, which will melt a total of 250 to 300 tons of iron per day. It will be noted that the charging doors are at a height of 27 ft. above the foundry floor. This height, which is greater than is usual, has been found conducive to an evener melt and economy in fuel consumption, as the heat generated in melting is conserved for heating the cold iron above.

While there is nothing novel about charging machines, mechanical charging in this instance is made through two cupola doors. Simultaneous charging through two doors, it has been discovered, makes for an even distribution of the iron and coke, thereby overcoming the chief objection to charging machines.

The Hercules plant occupies a tract of ground 313 by 550 ft., and is divided into three wings separated by open bays, which ensure ample air and light for the workmen and incidentally serve as storage space for flasks. The cupolas front on the largest wing, the main bays of which are devoted to the heavier work, including bases and fly-wheels, while the two bays on either side are used for moulding lighter fly-wheels, bases, and pulleys, and to snap flask work respectively. The second wing of the building is devoted entirely to the moulding of cylinders and work of a like nature requiring a special mixture of iron This third wing is occupied by the core department.

The men use portable moulding machines and start work at the connecting aisle, setting down their moulds as they are completed until they reach the other end of the moulding floor. To facilitate the movement of the moulding machines the entire plant, with the exception of the connecting aisles, has a concrete floor, covered with sufficient sand to protect the moulder as well as the floor surface. The connecting aisles, running under the mono-rail system, are laid with wood-block to prevent dropping iron from popping and frightening the men.

The Hercules plant is on an open-shop basis and piece-work rates prevail. That this method of compensation is conducive to production is borne out by records of output. To illustrate, two moulders on one floor regularly show a daily output of 170 moulds for 1½-h.p. fly-wheel castings, and it is believed that this production could be increased to 300 if a pour-off gang were used

Each foundry department has its own cleaning-room, equipped with Sly motor-driven tumbling barrels. There are 24 tumblers in all, the majority of which are square, 42 in. by 42 in. by 60 in. and 48 in. by 48 in. by 60 in., while a number are round, 36 in. in diameter by 60 in. in length. All of the tumblers are on roller bearings and are equipped with fly-wheel and safety brake There is but one sand-blast machine in the entire plant, it also being of Sly manufacture. Sand-blasting has been reduced to a minimum because it was regarded as more economical to spend money on facings than in sand-blasting. Facing sand is delivered to the sub-basement of each foundry department through trap-doors in the storage yard. From the basement the sand is conveyed by bucket elevator to the foundry floor. A Simpson motor-drive intensive rotary mixer fed by a scoop elevator is used for mixing facings.

Messrs. Sanders, Page & Company, metal merchants, etc., have removed to temporary offices at Balfour House, 119, Finsbury Pavement, London, E.C.2.

New Steel Castings Foundry at Hadfield's, Limited.

In connection with the annual conference of the British Commercial Gas Association, recently held at Sheffield, some 70 or 80 members attending the conference paid a visit to the East Hecla Works of Messrs. Hadfields, Limited, in order to inspect the new foundry for small steel castings which has recently been completed by the firm. Claiming to be the most up-to-date of its kind in the country, this foundry is replete with every modern device for the efficient and rapid production of the smaller steel castings used in collieries and other mines, engineering and other industries. Most of the buildings in connection with it were erected during the war period for use in shell manufacture. Since the war these shops have been stripped of all shell plant, and with various alterations and additions are now admirably suited for their new purpose. New buildings of various kinds have also been built to complete the scheme, which, as a whole, covers an area of 12½ acres, of which 7½ acres are covered by roofs.

The main building (about 4 acres), in which is housed the foundry and steel-making plant, is well equipped with modern plant, a feature being the use made of electric tractors for haulage purposes. It is capable of an output of 400 to 500 tons per week. While the foundry has been laid out to deal with all types of small steel castings for colliery, mining, engineering, and other industries, larger castings could be made if necessary. Included in the plant are heating fires, core and drying stoves, moulding machines, etc.; also there is installed a completely equipped compo mill, with sand storage accommodation, sand-mixing machines, and grinding mills.

The heat-treatment shop (about 1 acre) is equipped with 16 furnaces of the raised-bottom and roller-bottom variety; also tanks for quenching. Housed in this shop is an up-to-date sand blast.

The other shops include:—(*a*) A rumbling shop equipped with three electrically-driven rumblers; (*b*) a grinding and fettling shop (½ acre) fitted with a large number of grinding wheels, all connected up to a modern dust-extracting plant; (*c*) a machine shop (nearly ¾ acre); (*d*) an inspection, assembling and forwarding shop (nearly ½ acre); (*e*) a wheel and axle shop equipped with pneumatic hammers, smiths' hearths and dipping pans; (*f*) a moulding box shop; (*g*) a storage shed for coke, etc.; (*h*) a gantry for raw materials, 80 ft. span by 240 ft. long, fitted with a 10-ton overhead electric travelling crane suitably designed to work with an electric lifting magnet; (*i*) one 7-ton stationary electric luffing jib crane, 50 ft. radius of action, and associated with it a breaking-up tup.

All the shops are well fitted up with overhead electric cranes. Railway connections are coupled up to all necessary places, and there is installed a 2-ft. gauge inter-shop communication railway system with all facilities for dealing with the various classes of work.

It is estimated that when the new departments are fully equipped employment will be found for 500 workmen in the foundry alone, and with the annealing, machining and other departments, say 1,000 workmen.

At the annual meeting of the Sheffield Tool Trades' Technical Society, the following officers were re-elected:—President, Mr. T. W. Willis; vice-presidents, Messrs. W. S. Skelton, P. MacGregor, J. H. Barker, H. Colley, F. W. Clayton, and G. F. Hallett; treasurer, Mr. H. J. Haynes; hon. secretary, Mr. W. H. Bolton; and assistant secretary, Mr. R. Barker. Messrs. T. R. Ellin, F. Sanby, O. K. Everitt, and N. Webster were re-elected members of the Council, and Messrs. R. Tyzack (employers' representative) and Culley (workmen) were elected to fill two vacancies.

Admiralty Experiments on Aluminium-Alloy Pistons for Submarine Oil-Engines.

In a Paper read before a recent meeting of the Institution of Naval Architects, Engineer-Commander C. J. Hawkes, R.N., described some interesting experiments carried out in connection with Diesel oil engines. Particulars relating to material and design of pistons of submarine oil engines were referred to the Board of Invention by the Engineer-in-Chief of the Navy, and first considered at a meeting of the Internal Combustion Engines Sub-Committee on November 29, 1915.

Several designs of pistons were considered by the Sub-Committee, including pistons of aluminium alloy in two pieces, and also pistons having aluminium alloy heads and suitably lightened bronze or cast-iron skirts. Eventually it was decided to commence the experiments with a piston of aluminium alloy, and, in order to keep down the weight of the piston, a comparatively low copper content was decided upon. It was uncertain whether this piston would stand up to its work for any length of time, especially having in view the composition of the aluminium alloy then being recommended for pistons of aircraft engines, but it is interesting to note that the original piston is still in use, and it has been run for a considerable time at comparatively high speeds and high mean pressures.

The diameter of the cylinder of this engine (which, for convenience, is known as the "Unit" engine) is 14½ in., stroke 15 in., and of 100 nominal b.h.p. at 380 r.p.m.

After the engine had been running at the full nominal load for some considerable time, it was opened up for examination. It was found that the gudgeon pin was slightly slack in the connecting rod, and it was decided, therefore, to modify the skirt portion of the piston so that it would pass over the foot of the rod for dismantling, and thus permit a "shrunk in" gudgeon pin to be fitted.

When these modifications had been carried out, the engine was run at or above 100 b.h.p. at revolutions from 380 to 500 per minute, and at mean pressures from 100 to 140 lbs. per sq. in., and it was not opened out for examination again until July, 1918. It was then found that the piston was in good condition, but the white metal of the gudgeon brasses had worn slightly. It appeared evident that this wear was largely due to the fact that the oil grooves had not been cut exactly in accordance with the instructions on the drawing, and this resulted in reducing the supply of lubricant to the grooves. It was also found that the brasses had hammered very slightly in the aluminium body of the piston, and there was evidence that the side clearances between the connecting rod and the brasses were insufficient.

It was decided to bore the eyes of the piston larger, make new brasses of corresponding greater thickness, with flanges at each end, and to fit more substantial keys to prevent the brasses turning in the piston—as the small keys originally fitted were found to be slack. The experiments have been continued since August, 1918, at mean indicated pressures up to 140 lbs. per sq. in., but it has not been necessary to make any further modifications to the piston. Whenever the piston has been dismantled it has been found in good condition, and careful gauging has shown that there is no appreciable wear either in the body of the piston or in the grooves—and, so far, there is no indication of "growth." The cast-iron cylinder liner is in excellent condition.

The weights of the aluminium alloy piston and I section connecting rod of the experimental engine are appreciably less than the weights of the corresponding parts of the standard submarine engine, with the result that the inertia forces in the former at 500 r.p.m. are approximately the same as in the latter when running at 380 r.p.m. The comparative weights of the reciprocating and rotating parts of the experimental cylinder and the standard engines are shown in Table I.

TABLE I.—*Comparison of Weights of Pistons and Connecting Rods in Experimental and Standard Submarine Engines.*

	Experimental Engine.	Standard Submarine Engine.
Cylinder diameter	14½ in.	14½ in.
Length of stroke	15 in.	15 in.
Revolutions per minute	380	380
Weight of piston, with rings, bushes (in the case of experimental engine), guards, etc.	213 lb.	390 lb.
Weight of connecting rod, with gudgeon pin and large end bearing and bushes (in the case of standard engine)	290 lb.	423 lb.
Reciprocating weights (includes two-thirds weight of connecting rod without palm end)	310 lb.	560 lb.
Rotating weights (includes palm end and one-third weight of connecting rod)	193 lb.	253 lb.

With the particulars given in the above table the mean pressures on the various bearings throughout the cycle, at 380 r.p.m., were obtained for each engine, and the results are shown in Table II.

TABLE II.—*Mean Total Bearing Pressures Throughout Cycle in Lbs.*

Engine.	Gudgeon Pin.	Crank Pin.	Cylinder Liner.	Main Bearings.
Experimental engine	12,320	16,200	1,420	16,200
Standard engine ..	15,250	20,260	1,840	20,260

It will be seen, as would be expected, that there is a considerable reduction in the mean total loadings of the bearings, due to the use of the aluminium alloy piston and lighter connecting rod, and, as the mean rubbing velocities of the various bearings are the same for both engines at 380 r.p.m., this reduction is a measure of the increase in the mechanical efficiency of the experimental engine, as compared with the mechanical efficiency of the standard engine. This increase in mechanical efficiency would appear to be of the order of 2 per cent.

The co-efficient of linear expansion and the thermal conductivity are greater for aluminium than for cast-iron, and, in the absence of information so far as large engines were concerned, it was difficult in the design stage to decide on the clearances which should be provided between the aluminium alloy piston and the liner. It was essential that the clearances should not be greater than were actually necessary, and eventually it was decided to make the clearances similar to those usual with cast iron in Diesel engines, and to note the results. When the engine was first started, and after it had been running at a small load for some time the piston seized. The piston was removed and examined, and it was found that it had been in contact with the liner over nearly the whole of its surface, and the metal was scored slightly. The piston was

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therefore " draw filed " and replaced and the engine again put on load. At the higher loads there was a slight seizure, and again the body of the piston was filed where it had been bearing hard on the liner. Since that time, although the engine has been running at high speeds, etc., no further seizures have taken place. From the experience gained it may be taken that the clearances required with an aluminium alloy piston should be about 50 per cent. greater than the clearances necessary with a cast-iron piston. Should a cast-iron piston seize, it generally results in damaging the liner as well as the piston, but in the case of the aluminium alloy piston, it was found that a seizure did not damage the surface in any way. Further, it was found that as soon as the engine had cooled down slightly after a seizure, the aluminium piston was quite free.

There is no doubt, so far as present experience is concerned, that aluminium alloy pistons, although slightly greater in first cost, have many advantages over cast-iron pistons. Further experience will shortly be available as to their behaviour under actual service conditions, and it will then be possible to decide whether their extended use for submarines is justified. In the meantime other Admiralty experimental engines, including the two-stroke cycle type, have been, or are to be, fitted with pistons of aluminium alloy for further test.

In view of the results obtained with the " Unit " engine, it was decided further to test the capacity of the piston to withstand higher mean pressures by supercharging, and also to run at higher speeds. The two methods of supercharging considered were (1) to compress to the supercharging pressures the whole of the air required by the engine by means of a blower or pump, the air passing through the induction valve, or (2) to allow the engine to draw air from the atmosphere through the induction valve in the ordinary way, and to add at or about the commencement of compression the additional air for supercharging through ports uncovered by the piston, or through an additional valve in or near the cylinder head. The alternatives were fully considered, but as the principal object at that time was to test the aluminium alloy piston, it was decided to adopt (1), as it did not involve any structural alterations to the engine. It was consequently arranged to compress to the supercharging pressure the whole of the air required by the engine by means of a standard Roots blower, driven by belt from an electric motor. The blower delivered air under pressure to a reservoir, which was fitted with a combined relief and pressure regulating valve, so that the supercharging air could be adjusted to any pre-determined pressure within the capacity of the blower. A three-way cock was fitted in the induction pipe, so that the engine could take its supply of air either from the atmosphere or from the reservoir. This arrangement gave no trouble, but it was found that the temperature of the air delivered at 3 or 4 lbs. pressure after a time rose appreciably, and a water jacket was therefore fitted to the blower.

It may be interesting to mention, in connection with the " Unit " engine, that an obturator ring has been fitted to the piston since August, 1918, and has given fairly satisfactory results. The top of the cylinder liner of the St. Albans Electric Power Station engine was worn to the extent of nearly $\frac{1}{4}$ in. on the diameter, and the life of the phosphor bronze obturator ring under these severe conditions was about 300 hours. The general condition of the liner, however, was such that the ordinary type of cast-iron ring could not be used, and the fitting of the obturator ring, although its life was comparatively short, certainly enabled the engine to be run.

In the St. Albans engine the first three cast-iron piston rings were " pegged in " for the purpose of filling the grooves, and obturator ring of L section, and about 1.5 mm. in thickness, was fitted in the fourth groove, and the three remaining worn rings, below the obturator ring, were retained, unaltered. An appreciable clearance was provided between the edge of the obturator ring and the groove in which it was fitted. The question of the gas pressure behind the obturator ring during the cycle was discussed with the firm's representatives, and it was suggested to them that it would perhaps be an advantage to fit a cast-iron ring in the top groove of the piston, in order to protect the obturator ring from the hot gases. Later, when it was decided to fit an obturator ring to the " Unit " engine for experiment, provision was made for a cast-iron protection ring designed to give a radial pressure of about 1 lb. per sq. in. Further, the clearance between the edge of the obturator ring and its groove was reduced to 0.002 in.—as by this means it was considered that the pressure behind the ring would, by wire-drawing, be reduced to a minimum.

The material used in the obturator ring is phosphor bronze, and the thickness of the ring is 0.05 in. A lap joint, riveted and silver soldered to one end of the ring, is provided to ensure gas tightness past the gap. A filling ring is fitted, made in halves spigoted together —its width being such that it just allows freedom of movement of the obturator ring.

When the obturator ring was fitted to the " Unit " engine the compression ratio was increased, as it was uncertain whether the ring would be gas tight when starting up. Later, however, the compression was reduced again to 380 lbs. per sq. in. at 380 r.p.m. When the engine was first run with the obturator ring, especially for about 15 minutes after starting, an appreciable quantity of gas passed the piston into the crank case—which would be an objectionable feature so far as its use for submarine engines is concerned—so the ring was removed and eased slightly to give it more freedom. It was clear that only portions of the ring were in contact with the liner, and its surface was therefore smoothed up as necessary, and 11 slots, 1-32nd of an inch deep and 1-16th of an inch wide, were fitted. At the same time, the clearance between the edge of the ring and the piston groove was increased from 0.002 in. to 0.003 in. These slight modifications resulted in a distinct improvement, and the ring worked satisfactorily with mean indicated pressures up to 140 lbs. per sq. in.

No leakage was apparent, although the maximum compression pressure was very slightly less than that previously obtained with the full number of cast-iron rings with the same compression ratio in use. There was a very diceded knock in the piston at the end of the compression stroke, and after running for a total of about 30 hours, it was decided to examine the piston and obturator ring. The obturator ring was found to be quite free and bearing generally, and there was no measurable wear. The ring was therefore replaced, and, in view of the previous knocking of the piston, two additional light cast-iron rings were fitted below the obturator ring. These additional rings, which were intended to act as " buffer " rings, practically cured the knocking, but they must add slightly to the piston friction of the engine. It is probable that this knocking could have been avoided by reducing the piston clearance, but nothing could, of course, be done with the existing piston; neither was it desirable in view of running the engine at comparatively high mean pressures.

After running for about 150 hours at various powers the obturator ring was again measured, and the wear appeared to be about 0.001 in., whilst the maximum wear in the groove of the piston when gauged was found to be 0.008 in.

So far the obturator ring is promising, but it has been tested under very unfavourable conditions, and further experience is necessary before any recommendations could be made in regard to its general use in Service engines. The original ring is still fitted in the engine, but there has been no opportunity to ascertain the actual reduction in piston friction resulting from its use. There is no doubt, however, that the engine is more free than formerly, and its mechanical efficiency has been slightly increased. It is not known whether any experiments have been made to ascertain whether obturator rings would work satisfactorily when run-

ning over ports, such as those fitted in two-stroke cycle engines, but it is probable that this will be tried at the laboratory at a later date.

Very good results have been obtained with the "Unit" engine, both with the solid and with the air-injection systems. Instructions were received to carry out experiments with the object of reducing the tendency of the standard engines to smoke when using solid injection. A large number of tests were made, which cannot be referred to in detail here, and eventually smokeless combustion was obtained with the "Unit" engine at all powers from 100 b.h.p. to 25 b.h.p., and the consumption of fuel oil at 100 b.h.p. and 380 r.p.m. was just under 0.4 lb. per b.h.p. hour.

The aluminium alloy piston closely followed the design adopted for the "Unit" engine previously described. In view of the results obtained from the "Unit" piston it was thought that the 20-in. piston would probably run satisfactorily without any special means of cooling. As there was, however, a doubt about this, it was decided to arrange for oil cooling.

The engine was first started on October 28, 1919, and short runs were made, using Texas oil fuel. At the end of 100 hours' running at various powers, the engine was opened out for inspection, and the piston, top-end and bottom-end bearings, were found to be in excellent condition. The engine runs smoothly and well at the higher speeds. At the lower powers a very slight piston knock is sometimes noticeable, which would indicate that the piston clearance is slightly greater than necessary at these speeds. There is no knock, however, at the higher powers

The quantity of piston cooling oil circulated through the system when running at 314 b.h.p. at 314 r.p.m. was only 210 gallons per hour—the rise in temperature of the cooling oil being 64 deg. F. If we assume, therefore, that the calorific value of the oil is 18,400 b.th.u's (lower heating value), the quantity of heat carried away by the cooling oil is about 2.3 per cent. of the heat supplied. At lower speeds, and also at low mean pressures at the same speed, the percentage of heat passing to the cooling oil is slightly higher. It would probably be advisable to pass a larger quantity of oil through the piston and reduce the rise in temperature, but so far no alteration has been made to the engine in this direction.

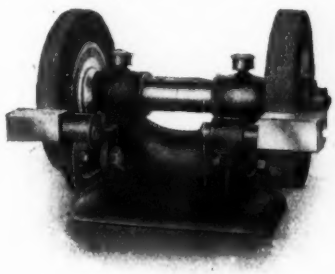
Further tests are, of course, proceeding, and later it will be possible to continue the tests at the higher speeds. So far no mechanical difficulties have been encountered, and it is not anticipated that any trouble will arise which will prevent the engine developing at least the rated net b.h.p., *i.e.*, the b.h.p. arrived at after making full allowance for the power required to drive the air compressor.

THE SWEDISH IRON INDUSTRY.—In a recent address to the Swedish Technological Association, Prof. Arvid Johansson declared that the Swedish iron and steel industry must produce more cheaply if it is to hold its own. Particularly does this apply to the question of fuel consumption, and the Professor looks for its solution in making the various processes follow each other in rapid succession from the molten pig-iron to the open-hearth furnace and ingot rolls.

CORONA METAL.—An alloy, termed P. R. Corona metal, which was recently shown at Olympia, has a colour and lustre like nine-carat gold, and is said to be capable of resisting atmospheric conditions, sea water, chemical fumes, etc., which would corrode and pit brass or any other copper alloy. With a tensile strength of 20 tons per sq. in., an elongation on 2 in. of 24.4 per cent., and a reduction of area of 24 per cent., it is stated to be practically as ductile and malleable as gold, and it can be drawn cold into wire of very small gauge and rolled, hot or cold, for any purpose for which wrought metal is required. It is said to make castings that are clean, close-grained, sound, and free from blowholes.

The "Griffin" Bench Grinder.

The annexed sketch shows a Griffin bench grinder, for which the Trading Engineers Company (16, Grosvenor Gardens, London, S.W.1) are selling agents for London and district. It is claimed for this machine that:—(1) The bearings are of Glacier anti-friction metal of exactly the same quality as those used on the airship R. 34 (the first to cross the Atlantic). (2) Each



machine is fitted with Stauffer grease cups, the bearings being grooved to admit of free lubrication. (3) The adjustable rests are of special design to meet all ordinary requirements. (4) The casting is of best grey iron of first-class workmanship and clean finish. (5) The spindle is finished to a gauge limit not exceeding 1-2,000th of an inch. The makers are Messrs. C. N. Bramley, Ltd., Humberstone Road, Leicester.

NON-MAGNETIC RUST-RESISTING STEEL.—At a recent meeting of the American Steel Treater's Society, Charles M. Johnson, director of research department, Crucible Steel Company, described the "Properties and Microstructure of Heat-Treated Non-Magnetic, Flame, Acid- and Rust-Resisting Steel." The analysis was not given, but the statement was made that the carbon was 0.3 to 0.4, and micrographs of ingot structure indicate it to be a complex alloy which reverts to a homogeneous solid solution upon annealing at 1,300 deg. C. (Brinell 160), and upon very long-continued tempering—a matter of days—allows an excess constituent to divorce itself and become spheroidised. It is quite non-magnetic—its residual magnetism after charging did not exceed four dynes per sq.cm. It resists staining and rusting remarkably The resistance to corrosion is compared with other well-known steels as follows, the figures representing loss in grams per sq. in. in 24 hr.:—

	Glacial Acetic.	10% H_2SO_4	32% HNO_3	19% HCl.
New steel	6.1	3.2	0.4	33.3
Monel metal	0.7	1.3	soluble	13.1
High Cr-Si steel ..	0.0	soluble	0.5	—
38 per cent. Ni steel..	13.8	4.1	soluble	19.0
High Cr steel.. ..	0.7	soluble	0.1	soluble

Approximate physical test results on the new steel are as follows:—

	E. L.	Ult.	Elong.	Reduc.	Brinell.
Heated 5 min. at 2,400 F. ..	90,000	120,000	30	45	230
Quenched in oil from 2,000+F.	60,000	110,000	50	60	200

Although the metal can be forged, rolled, or sheared in thicknesses 0.1 to 1 in., and is machinable, it offers a maximum resistance to prolonged heating at temperatures up to 2,000 deg. F. and is cut by the oxy-acetylene torch with the utmost difficulty.

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The Manufacture of Moulding Boxes.

Concurrently with the development of mass production in the automobile industry came a transformation in the methods of manufacturing the various parts which comprise the complete motor car. These changes affected practically all processes, including that of producing castings.

Foundrymen who previously had received orders involving hundreds of castings from a single pattern were compelled by the demands of automobile builders

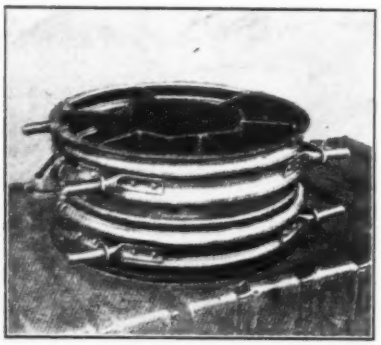

FIG. 1.—CIRCULAR-TYPE FLASK ILLUSTRATING TYPICAL BARRING CONSTRUCTION.

to seek equipment suited for the economical production of thousands of identical castings.

The new requirements were met by adopting machine moulding on a more extensive scale, and by employing more durable patterns and moulding boxes. Cast and pressed steel came into wide-spread use, and at the present time practically all of the engine castings and

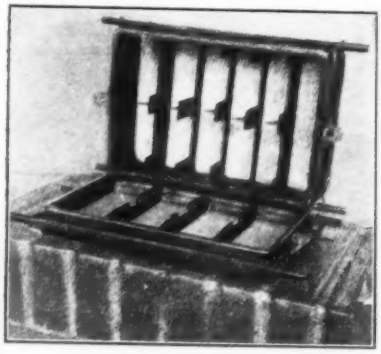

FIG. 3.—FLASK USED FOR CASTING TRACTOR PARTS.

most of the other cast parts of automobiles are poured in metal boxes. Because of their lightness, rigidity and durability, pressed steel boxes are being used for moulding automobile pistons, flywheels, truck wheels, rear axle housings, tractor parts, etc.

Among the companies which recently have engaged in the manufacture of steel boxes is the Truscon Steel Company, Youngstown, O. Stock from which the flasks are made is copper-bearing, open-hearth, medium blue annealed plates, 60 × 100 ins. It is rolled by outside mills in thicknesses of 5-32, 3-16, 7-32, and ¼ in. Upon delivery to the works the steel is piled in a warehouse, which is built at right angles to the building housing the pressed steel department. An electrically driver shear, equipped with an adjustable stop gauge on the back table, is built at the end of the warehouse nearest the pressing department. The plates are taken from the stock pile as required, placed on a pressed steel platform, and transferred to the shear, where they are trimmed or cut to the exact size for forming the particular flasks on order.

After the cut is made the blanks are piled on a steel platform and taken to a large press in the forming department, where the first operation is performed.

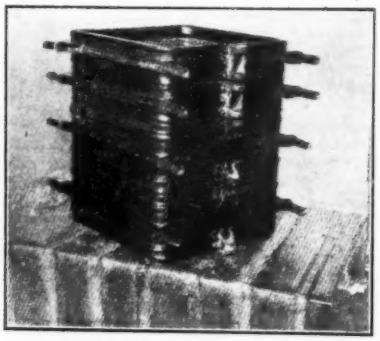

FIG. 2.—FLASKS USED FOR MISCELLANEOUS WORK—PROVIDED WITH DOWEL-PIN BRACKETS TO ENABLE THEIR BEING BUILT TO ANY DESIRED HEIGHT.

This consists of stamping one or more ribs on 3-in. centres according to specifications. Sections 3 ins. high are made with one rib, sections 6 ins. high with two ribs, etc. Where a section is built with two or more ribs, the latter are pressed in the metal one at a time in order to avoid stretching the steel. The top half of each rib is made with a steep slope in order that the sand will slide in position easily when the flask

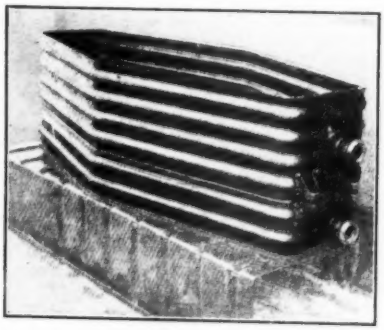

FIG. 4.—FLASK USED FOR CASTING REAR AXLE HOUSINGS FOR TRUCKS.

is placed in service; the bottom half of each rib is made shallow and acts as a shoulder, upon which the sand rests.

To provide a place for clamping the cope to the drag and to permit the ramming of sand without interference, the practice followed by the company is to turn the top flange of the cope and the bottom flange of the drag outward and the sand strips inward.

Some users, however, desire both flanges turned inward. After the flanges have been formed the next

operation is to turn the corners. Before this can be done, however, it is necessary to anneal the steel at the place where the bend is to be made in order to relieve the hardness introduced to the steel during the forming operation.

The steel is removed from the flanging press, placed on the floor, and the flanges heated with an oxygen-acetylene gas flame. The die used for turning the corners is of the built-up type , and affords the stamping of any number of ribs of any width. Round flasks are formed in a similar manner. as the square types with the exception that the built-up die strikes each half section three or four times while only one stroke is required to round the corners of the square flasks.

After the corners are rounded the shells are inspected, matched and taken to assembly benches, where two sections are clamped together to form the flask. In this condition they are transferred to the welding shop, which is housed in a separate building off the pressing department. The welding department is equipped with eight electric welding machines, these being operated in individual compartments. At this stage in the process of manufacture only the inside seams are welded. The flasks then are taken to the drill presses, where four holes are drilled in the centre of each end for the dowel brackets, and four additional holes near the rounded

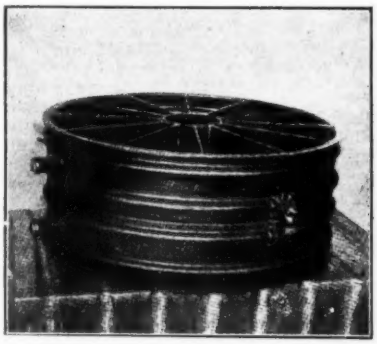

FIG. 5.—CIRCULAR FLASK WEIGHING 208 LBS. USED FOR CASTING TRUCK WHEELS

corners for the handle and handle brackets. The dowels, which are made of malleable iron, then are drilled, and the whole taken to the riveting department, where the handles and brackets are attached with 5-16 in. rivets driven hot. Gas muffle furnaces are used for heating the rivets.

The stock then is returned to the welding department for welding the cross bars in place. Prior to this step, however, the bars are lined up by a jig. Certain foundrymen order their flasks with the bars welded on one side and riveted on the other. Ordinarily the bars are welded in place. Several types of flasks, particularly those of heavy construction, are equipped with trunnions, which are formed from 2-in. steel pipe with collared ends. A heavy ring is welded in the centre of each trunnion to form a second collar, and the whole welded to the sides of the flask. Malleable iron trunnions originally were used, but the above method has been adopted owing to the difficulty of obtaining castings. A flask was equipped with welded steel trunnions, and after being loaded with two tons of steel, the whole was lifted by a crane, the trunnions bearing the entire weight. As no deflection of the trunnions or walls of the flask was noticed the test was carried further by hammering with a heavy sledge. Numerous blows failed to break the trunnions at the weld, although they did cause the trunnions to break a short distance away. Four short steel pipes, 1 in. in dia., are welded to the corners of the flasks equipped with trunnions to afford easy handling. In preparing these handles they first are heated to the desired temperature in a gas-fired muffle-type furnace, and then taken to a small press, which flattens and grooves one end. The grooved end is welded to the side of the flask, the open end of the pipe forming the handle.

After any extra metal due to the welding process is ground off, the flasks are transferred to a table where by means of jigs the dowel pin holes are accurately drilled. The holes then are reamed. At the beginning of the manufacturing process the flasks are made 1-8 in. higher than specifications, in order to provide enough leeway for flattening upon completion of the work. The final pressing of the flask to make it conform to specifications removes any twists and leaves the sand strips smooth. Any dents in the sand strip, which the press fails to remove, are eliminated by hammering when the flasks arrive at the inspection benches. After a rigid inspection the flasks are shipped.

Fig. 4 shows a double tapered flask made from 7-32 in. plates and weighing 225 lb. The cope is 12 in. and the drag 7 in. Flasks of this type were built for use in casting rear axle housings for automobile trucks. The shell of the flask is drilled to receive cast-iron bars for the various types of axles made.

The type of flask shown in Fig. 2 is used extensively by a manufacturer of electrical equipment. The size is 18 × 18 in., the various sections being 4 and 7 in. high. Inasmuch as the flasks are used for miscellaneous work in the foundry, both flanges are turned inward. In addition the flasks are provided with dowel-pin brackets at both the top and bottom in order that the flask may be built to any desired height. Fig. 3 shows a 19 × 28-in. flask with a 9-in. cope and 3½-in. drag, which was made for a tractor company. The illustration shows the method employed for attaching the bars to the sides of flasks intended for special jobs. The cope and drag shown in Fig. 1 each are 20¾ in. dia. and 5½ in. high. Flasks of this type also are used extensively for making tractor castings.

The flask shown in Fig. 5 was made for casting truck wheels. It is 36 in. dia., with an 8-in. cope and an 8-in. drag weighing 208 lb.

A NEW MAGNETIC ALLOY.—This consists of copper, manganese, and aluminium in proportions that give an average atomic weight of 56.3. In this connection it is interesting to note that this alloy and a few notably magnetic elements have nearly the same atomic weight. These are iron, nickel, and cobalt, with respective atomic weights of 55.8, 58.7, and 59. The atomic weight of manganese, which is feebly magnetic, is 54.9.

CORROSION OF ALUMINIUM. — To protect aluminium and aluminium alloys from corrosion, L. von Grotthus has tried browning the metal electrolytically. The aluminium is suspended in an electrolyte consisting of a sulphur compound of molybdenum with a zinc anode at a temperature of 60 deg. to 65 deg. C. The aluminium is soon covered with a dark brown coating, and may be bent or rolled without cracking the coating. Aluminium thus treated was immersed in a salt solution for two months without showing the slightest trace of corrosion.

FOUNDERS' ASSOCIATION OF CLEVELAND.—At the first autumn meeting of the Founders' Association of Cleveland, held September 21, C. S. Koch, president of the American Foundrymen's Association and of the Fort Pitt Steel Castings Company, McKeesport, Pa., referred to the present foundry situation and urged foundrymen to devote more attention to the subject of costs, so that in case competition for business became more brisk, makers of castings would be able to figure their costs more closely, but, at the same time, quote prices that would assure them a profit.

The Production of Good Iron Castings.*

By Dr. Richard Moldenke.

Any discussion on the production of good castings will always bring out at least two strong view-points. There is that of the purchaser of these castings who invariably wants them to be perfect and cheap. Only in times like these must he take practically what is given him and at figures set by the foundryman. These times, however, will not remain very long, and the foundryman will shortly be confronted again with strict demands for smooth surfaced, sound, strong and machinable work at low, competitive figures. Hence the importance of keeping up quality production in spite of the temptation to let everything pass out of the shop.

From the standpoint of the foundryman it is equally essential that the work produced should be of high quality, for every rejected casting costs as much as the corresponding good one, and yet, on remelting, has only scrap value, for it can be replaced thus in the open market. Few foundrymen realise that molten metal wasted in unnecessarily large risers and pouring basins, spilled and "over-iron" comes under this category and should therefore be reduced to a safe minimum. For this reason also should the breaking in of new men be followed up carefully to judge whether within a reasonable time each man has made sufficient progress to justify the further losses still ahead before adjudging him a skilled operative. Moulding is an art, even if a machine performs a part of the work, and not every man is gifted with the necessary qualifications.

From the view-point of the nation as a whole, it is essential for the economic advance of our industrial life that the pound of iron be made to go further than ever, and hence the indiscriminate use of masses of low grade metal must give way to less material of higher grade in construction work of modern design, consistent with the requirements of service and safety. It is incumbent, therefore, upon the foundryman to study every phase of the numerous processes involved in his work so that he may know himself to be industrially successful, as well as commercially so. There are few industries in which the chances of failure are so great and pit-falls are to be found at every turn. The slightest mistake at any one of the hundred different operations involved in the making of a casting may mean its loss, if not something more serious, and only the resourceful and energetic man may strive to become a successful producer of good castings.

In general, the subject under discussion may be briefly summed up under three heads. First, it is necessary to work with good materials in foundry procedure. All melting processes are necessarily oxidising in character to a greater or less extent, and hence an "off" pig iron or "burnt" scrap is not subject to improvement by remelting. Again, a moulding sand full of fluxes may mean disaster to the surface of a heavy casting, while high sulphur coke will surely increase the scrap pile. Second, even with the best of materials good results will not be achieved unless these materials are put through the necessary processes with the required degree of skill and attention. Hence good moulds must be made from the right kind of sands, and the mould surfaces must be properly finished and blackened. Good pig irons and carefully selected scrap must be charged judiciously and melted under practically perfect furnace conditions, so that when the molten metal is tapped out, the foundryman may be certain that it could have been no better for the class of work in hand.

Finally, the gating of the moulds and riser arrangement should be planned and carried through with scientific accuracy, if such a term may be used in a foundry. Then the carefully selected materials which have been melted under exact charging and blast conditions and have yielded a molten metal full of life will be given a fair chance to be converted into castings free from undue internal shrinkage, casting strains and other trouble.

The Sulphur Problem.

The tragic industrial condition of the world during and since the war is perhaps best illustrated in the foundry. With pig-iron and coke almost beyond reach and necessarily poorly made; with labour below all comparison with anything the foundry has ever had to suffer in its history, no wonder there is a surfeit of abominably high sulphur, low grade work in existence which is accumulating trouble in the industry for this and the generations to come. It will require a high order of industrial education to cope with the situation when the castings made since war began appear in the scrap pile. As the strain in our industries tapers off, the furnaceman will again obtain better fuels and ore and can, if he will, furnish better-made pig metal. Competition will eventually bring the foundryman better fuel, and it is only the scrap which he has to buy that will give him serious concern as regards his raw materials.

While a high pig percentage in the mixture helps to overcome the sulphur difficulty to some extent, this is not always practicable in times of sharp competition, and hence only a thorough knowledge of cupola charging and melting will give fairly satisfactory results in spite of the scrap handicap. Since it is possble to make serviceable and machinable castings with sulphur as high as 0.30 per cent., provided everything else is correct, there is no reason why the foundryman should not be able to hold his own. There are, however, few foundrymen who are posted so thoroughly and can work in the exact routine the necessity of the case demands. Hence there is bound to be much disappointment ahead.

The question of moulding sand is becoming more serious in some sections of the country. The best deposits are verging upon exhaustion, and there is need of more careful sand preparation in the shop, to correct the difficulties with the natural product. Europe is ahead of us in this particular, in many instances all of the sand used daily going through machines for regrinding and mixing. Thus, after removing the burnt sand adhering to the casting as shaken out, and with the most economical use of seacoal, enough new sand is ground in to keep up the quantity and bond of the heaps to standard. While the eventual solution of the sand problem lies in preparing it artificially, from even-sized rounded grains of clean silca coated with high refractory and fat clays, much can be done by grinding the natural sands to promote their uniformity in texture and bond. As time goes on, foundrymen will demand better sands, and the sand merchant will have to add equipment to his plant to produce the goods. In the meantime, however, foundrymen will do well to test their sand-heaps regularly for fineness, strength and the bonding value of the clay content. Further, they should classify their work into light, medium and the heavy grades and arrange the sand heaps accordingly, and see that these heaps are not mixed. A fine sand mixed with a coarse one simply reduces the venting power of the latter without giving very much smoother work.

As regards the finishing of the mould surfaces, there is this much to be said. Moulding sand is composed of three distinct ingredients, namely, the silica grains, the clay substance forming the bond, and the fluxes

* An address delivered at the convention of the Southern Metal Trades Association at Atlanta, Ga., June 20-21.

that are unavoidably present. Originally a granite, the decomposition of this rock due to natural causes has given the unaltered quartz, or silica grains; and the feldspar and mica portions more or less completely decomposed. The fully decomposed portions have formed the clay substance, and the undecomposed parts contain the alkalies which count as fluxes. Unless the percentage of fluxes is very low, the moulding sand is bound to stick to the surface of the castings poured into it, particularly if the sections involved are quite heavy. To prevent, or at least counteract this as much as possible, it is necessary to cover the sand surface with a film of refractory material which will allow the easy peeling off of the burnt sand when the casting is shaken out. The best material for this film is graphite, and while used universally for the so-called "blackening" of the mould, there is nevertheless much still to be learned on the subject of making this film adhere to the sand and resist the washing action of the molten metal.

The Use of Sea-Coal.

The fact that only the immediate surface of the mould is subject to the intense heat and corrosive action of the molten metal, and not the main body of the mould itself, would seem to imply that the use of sea-coal for mould facing sand purposes is a somewhat crude makeshift and expensive at that. This all the more when these sand surfaces are afterwards finished off with graphite. Instead of preparing perhaps a quarter of an inch of the sand pressed directly against the pattern with sea-coal mixed in rich proportion, fully 2 in. of sand are often used, and as most of this goes back into the sand-heap, the bond in this is correspondingly weakened.

The ideal method is to remove as much of the burnt sand as possible with the casting, replace with new sand—using no sea-coal—mixing up the heap thoroughly and finishing off the moulds made with graphite blacking of proper quality. In this way the bond of the heap will be kept practically up to that of new sand and the usual difficulties met with when poor backing sand comes in contact with hot metal washing against it are avoided. It may not be possible from the nature of the work to apply this method, nor have we sufficient information as yet regarding the manner of coating the mould surfaces so that the graphite will not wash away to a greater or less extent. The preparation of the mould surfaces is, however, one of the big problems of the foundry that must be solved in the future, and our investigators would do well to give it the necessary study.

The Making of Cores.

The making of cores is also a fruitful field for study. In effect, a core is the counterpart of a dry-sand mould without the protecting envelopment of the flask. The core is at least partially covered with molten metal and must have exceptional venting facilities to allow the escape of gases formed during the pouring process. With high strength and permeability to air and gases, the core must be so constituted that it will disintegrate at the contact surfaces as the metal sets so that this may contract without danger of rupture. The selection of the sands and binders used in coremaking is, therefore, most important, the ideal method being to get a mixture as low in clay content as can be used successfully, with the binder evenly distributed and in lowest safe quantity.

The drying should be sufficiently long to accomplish two purposes. First, to evaporate all the water contained. Then to subject the binder to the maximum temperature it will stand before losing its value. In this way the cores will not only be dry and therefore not "blow" if vented properly, but they will not be so apt to absorb moisture from the damp mould body and give trouble. Cores, particularly the large ones, are usually made with too much moulding sand or loam in the mixture. There is also the tendency to feed in too much burnt core material. The consequence is a core so hard that the resulting castings are at least badly strained if not actually cracked.

The Selection of Pig-Iron.

Pig-iron should be selected on the general principle that the closer the analysis of the iron approximates to that of the castings, due allowance being made for oxidation and the scrap content, the better the chances for uniformity. In other words, it is not good to mix irons high and low in silicon or manganese, or to combine "off" irons with the fine charcoal grades. A study of cupola melting will show that there is no chance for actual mixing within the cupola until the metal passes out of the tap-hole. The presence of the incandescent coke in the crucible of the cupola prevents any movement of the molten metal while held there. Again, as the metal passes over the spout into the ladle, the churning action within this is not deep. Hence it is quite possible for high and low silicon metal to remain entirely apart even in the actual casting, and many are the notable examples of different compositions in large castings for which the mixing and charging was defective. Far better to have the metal yard filled with average analysis requirements, and but little of the high and low material for adjustment purposes.

Scrap bought for the foundry should be scrutinised carefully and all oxidised material refused. Eventually rigid specifications will rule in the scrap market so that when buying machinery scrap every piece will show evidence of tool action. As long as charcoal irons are obtainable, they will give the foundryman valued service for special lines of work, particularly for low silicon requirements as in chilled rolls, crusher parts, balls, etc. Also for very light work requiring great strength and elasticity. The fuels used in the foundry to-day are manifold. Coke, coal, gas, and oil, with electricity just ahead. Eventually coke with less than 14 per cent. ash and 2 per cent. sulphur will be again obtainable, and the relief will be correspondingly great. It is regrettable to see so much coke storage in our foundries out in the open. The bed coke must be kept dry in any case, and so long as the intermediate coke charges are measured in order to get a fair approximation to the weight, the water contained does not matter, particularly with very light and highly cellular varieties. Where, however, water or ice is weighed and charged as fuel, the consequences are all but pleasant.

The analysis of castings for all classes of work are now pretty generally known, so that the foundryman should have little difficulty in selecting his irons. In his mixture-making, he should not be too economical of good metal and must select his scrap with utmost care.

Metal Patterns.

Turning next to the processes through which the well-selected foundry raw materials are converted into good work, the most important will be those of moulding and melting. The constantly widening application of the moulding machine, as a consequence of the decadence of the skilled moulder, and the necessity of supplanting manual labour wherever possible on general principles anyhow, has brought about a closer study of the pattern question. Metal patterns are now the rule instead of the exception—wherever weight does not militate against this. This development makes for increased accuracy and also facilitates the mounting and special arrangements for quantity production. Jarring machine development has extended the use of cores, amounting in effect to an amplification of dry-sand moulding methods. The result of it all has been economy in labour, lost castings, and excess weights. Not only has the moulding time been shortened materially, but the equipment necessitated has operated for smaller losses chargeable to the moulding floor. The regrettable feature of the situation is the passing of much of

the loam-moulding talent formerly available, and this class of work is now confined practically to the very largest lines of work.

A further word about moulding sand. The essential items to be considered are the following :—The finer the grain size of the silica content of the moulding sand, the smoother the work. Necessarily the poorer the venting quality. Heavy castings, therefore, are made in coarse sand. The rule is to use as fine a sand as the work will safely stand. Again, the rounder the grain, the better the venting. Hence, apart from the question of bond, a round-grained sand is to be preferred—particularly with inexperienced moulders, as this can be rammed harder safely.

The bonding material of the sand—the clay substance—is most important. If strong, 5 to 10 per cent. is sufficient; if weak, 20 per cent. may be necessary. So high a proportion, however, means the filling up of the venting spaces and consequent trouble. Fortunately nature has attended to this situation, and coarse sands usually have less clay and fluxes than the fine ones. This clay bond, besides being very adhesive when dampened, should also be highly refractory, or free from fluxing impurities, and hence the definition of a good moulding sand would be "one of uniform size, rounded grains of quartz, each grain coated with a minimum amount of a strong, refractory clay." Nature, unfortunately, does not provide a theoretically perfect sand, and hence it is one of the problems of the future to improve existing sands, if not to actually build up artificial sands with practically perfect quartz grains and fireclay combination.

Successful Cupola Melting.

In the melting processes, the cupola furnace, as the easiest and cheapest method, comes in for most attention. It is the apparatus universally used for converting exactly proportioned mixtures of pig and scrap into highly super-heated molten iron for pouring off moulds. In lesser measure the air furnace is made use of in the foundry; the open-hearth furnace rarely. The crucible furnace is obsolete in the iron foundry, and the electric furnace is just getting a foothold at the present time, being ideal for particularly high quality, low sulphur castings for special service conditions.

There are two places in the foundry where particularly competent men should be placed. One is on the cupola charging platform, and the other in the sorting room, where the bad work is separated out. As so much depends upon converting the metal charged into the cupola into serviceable molten material, and the slightest deviation from standard practice may result in higher losses, particularly if much machining is done, it is obligatory to provide for conscientious weighing, uniformity in the sequence and distribution of the items making up the charges, blast regulation, etc.

The basis of successful cupola melting is unquestionably the height of the fuel bed. This should not only be kept at proper height, but should remain level throughout the heat. Only careful spreading of the pig and scrap, with the layer of coke above, will preserve this level; and the height is a function of the metal and fuel proportion, the blast remaining constant. The blast volume is most important, as will be understood from the following: The oxygen of the air blown into the cupola permits the combustion of the coke, thereby evolving the heat necessary to melt the iron. It is essential that this combustion of the fuel be as complete as possible, or the carbon turned into carbon dioxide gas. A pound of carbon of the fuel will thus yield 14,500 heat units. This carbon dioxide gas is, however, able to dissolve incandescent carbon and make another gas called carbon monoxide and, if allowed to do so by having too high a bed, the pound of carbon in question will have only yielded 4,400 heat units; the other 10,100 heat units are lost, being locked up in the new gas, which catches fire and burns as it is met by the air drawn in at the charging door. Thus about two-thirds of the available heat of the fuel would be wasted and dissipated in the atmosphere.

Hence the supreme importance of the proper height of bed to get the maximum of carbon dioxide, a minimum of carbon monoxide, corresponding to the point of highest temperature with maximum superheat of the molten metal produced. A further point is that this position of the bed also means the practically complete utilisation and elimination of the oxygen of the blast, thus avoiding the dangers of oxidised metal for pouring the moulds.

As the blast passes through the tuyeres it goes inward and upward through the coke bed, oxygen being used up until gone. With a steady stream of air the velocity of the gases formed within the bed will remain constant, and hence it is possible to adjust the bed height to be just right for a given set of cupola conditions. That is, once the proper height is known, it can be kept at that point provided the blast volume is not changed by meddling with the blast gate speed of the blower, and by seeing that the intermediate coke charges just replace the upper part of the bed burned away. If the blast volume is adjusted properly to the diameter of the cupola inside the lining, the blast pressure will be normal within high and low points incident to the interior conditions at the end and the beginning of a heat. Thus, with a cupola 54 in. diameter inside the lining there should be 10 tons of iron melted an hour. This means that with 30,000 cu. ft. of air drawn in by the blower per ton of iron to melt, 300,000 cu. ft. per hr. or 5,000 cu. ft. per min. air must be put into the bed of the cupola. This gives the number of revolutions of the blower per minute. And these revolutions should not be changed from beginning to end of the heat unless serious consequences are wanted.

Forcing the Cupola.

Forcing the cupola by blowing in more air means a higher gas velocity in the bed, which must therefore be made higher to get the ideal melting position. The uncertainties within the cupola under such forced conditions are increased tremendously, and too great a chance taken. It is not good practice to force a cupola. Better to lengthen the heat or augment the capacity by increasing the diameter, if possible. On the other hand, by decreasing the blast volume below normal, the velocity of the gases within the bed is reduced, and unless the bed is lowered there is danger of the formation of the previously mentioned carbon monoxide, with loss of efficiency in the melting operation.

Moreover, the tendency of the blast is to hug the lining and leave the centre of the charges only partially affected, thus heaping up a cone in the centre of the bed and causing irregular melting. The proper thing to do is to run the cupola at full capacity and, if the iron comes too fast, to shut off the blast completely periodically to stop melting long enough to allow disposal of the molten metal. It is necessary to open one of the peep-holes in the tuyeres at least partially to prevent the gases from backing up into the blower, with disastrous consequences when starting to melt again.

Determining the Height of the Bed.

An easy practical way of determining the height of the bed is available to the foundryman. He has only to leave the tap-hole open until a stream of molten metal appears and actually runs over the spout. By allowing sufficient molten metal to flow, this being used to heat the ladles, to insure a safety hot tap-hole, this can be bottled up for accumulation of metal for the first tap. The foundryman should count the minutes from "blast on" to "first iron" as it runs over the spout. This should not be less than eight minutes nor more than ten. The drops of metal passing the tuyeres should be seen in about six minutes. The bed charge is adjusted from day to day until these figures

are obtained, and the result is the correct bed height which, with properly regulated blast conditions, should be about 24 in. above the top of the tuyeres, of which there should be but one row of proper size.

Effects of Improper Melting.

Now for the bad effects of improper melting practice. Too high a bed means that the cupola is running partially as a gas producer. The iron is melted too high up, where the bed is no longer at maximum incandescence. The result is that the individual drops of metal are not given sufficient super-heat where they form, and do not require it in passing through the hottest portion of the bed below. While, therefore, the iron may be very good so far as quality is concerned, it is too cold for regular work. Too low a bed, on the other hand, means equally cold iron, for it has been melted below the point of maximum temperature of the bed. There has been, however, an exposure to free oxygen still in the blast, and the consequence is a dissolved iron oxide which raises the freezing point to such an extent that this iron cannot be held in the ladle for any length of time. It has no life, as the foundryman designates the condition, and must be poured quickly. When an iron such as this is poured into the mould it sets too fast for proper feeding, the gates are cut off too quickly, and the result is serious internal shrinkage. More than this, the quantity of dissolved gases is great, and a reaction between any oxygen present with the carbon, which may still go on while the molten metal sets in the mould, results in gas bubbles, which rise under the cope, are caught by the skin of metal already formed, and reveal themselves very disagreeably when the castings are machined. Besides this, there are the undue casting strains, cracks, cold-shuts, and other troubles.

The old foundry remedy of dividing the metal and coke charges, usually resorted to when things get desperately bad, is an instinctive feeling that all is not well with the fuel bed. Indeed, the cutting in half of the distance the bed may go up and down during the melting by using half the charges is exactly in line with the scientific correction of the trouble. It is the heavy fluctuation of the height of the bed that accounts for the fact that good and bad castings are made from the same charges, the moulding conditions being right. The last portion of every charge, if too large, gets down too low, and the resulting molten metal is damaged correspondingly by contact with free oxygen. The poor opportunities for mixing the molten metal in the cupola have been dwelt upon, also that of metal in the ladle. Where very heavy charges are used, this bad condition is intensified, and not only good and bad iron may alternate in the ladle, but actually hot and cold.

Importance of Proper Sorting.

Reference has been made to the importance of the man in charge of the sorting room. He should not only be competent to inspect the work carefully, but should be able to judge the cause of the trouble. Further, he must be in constant touch with the machine shop, to see how the castings finish up. All lost work should be carefully classified on the records, so as to include losses from poor moulding, bad sand, cores, poor iron, hasty pouring, etc. Then each foreman will know what he is up against and is expected to correct. There is no reason why cores should "blow" more than once in repeat work. Sand difficulties, as also pinhole troubles, are not so easily overcome, as it is impossible to regenerate a sand-heap overnight, or to correct the quality of the iron where the returns go into the mixture regularly. Such troubles come slowly and go away slowly. It is up to the foundryman to prevent them from reaching an acute stage at any time. Since the reputation of a foundry rests in great measure upon what passes out of the sorting room, the suggestion of putting a good man there is obvious.

Gating the Moulds.

The final point on the subject of gating the moulds is not so easy to discuss as it would seem. Some fundamental facts must first be brought out in order to understand what goes on within the mould while and after pouring. The terms "shrinkage" and "contraction" must be better defined. The structural condition within castings which have not been fed up properly is called "interior shrinkage." The reduction in length or other dimension incident to a casting from the time it has set to ordinary temperature, erroneously called "shrinkage," is really the "contraction." Shrinkage is more familiar to the foundryman working with low silicon irons, and he fears this phenomenon perhaps more than any other. The broken casting shows porous spots or actual cavities, which are lined with a pine-tree crystallisation. This is always located in the heavier sections, and where simply unavoidable ordinarily must be overcome by the use of "chills." The serious situation is that it is impossible to detect the trouble by even close inspection of the casting, the uncomfortable truth appearing only when failure has resulted in service. The possibility of interior shrinkage is intimately tied up with the gating up of the mould, and hence should receive most careful study, and, if possible, practical trial where the quantity ordered warrants it.

A given number of pounds of iron occupies a larger volume in the molten state than in the solid. The volume of liquid grey iron may be 5 per cent. larger and liquid white iron over 10 per cent. larger than these irons if allowed to contract solid. Since, after pouring, the mould filled completely with molten metal remains completely filled with solidified iron, the process operating successfully from the surface inward, the reduction in volume can only result in a considerable void in the casting where the metal remained liquid last, unless provision is made to introduce more molten iron into that spot. It is part of the art of the foundryman to do this very thing.

The conditions favouring the feeding of the castings are the following:—The use of "risers" or reservoirs taking up the overflow of metal through the top of the mould at given points, from which molten metal can be sucked back into the mould as the casting needs it. The fact that the comparatively narrow gates used for the entrance of the iron from the ladle have so much superheated metal passing through them that they become intensely hot is the reason why they allow molten metal to pass by when the same section in the casting would have set long ago. The placing of the gate at such a point, or at several points, so that the metal has to travel but a short distance before becoming stationary and setting, prevents excessive cooling at dangerous points, and allows feeding to go on better. Then, also, the placing of a gate such that no liquid metal is trapped by the setting of thinner sections about it cuts off the supply of liquid metal prematurely.

The General Principle in Gating.

In general, the principle is that the molten iron should travel to the end of its run and stay there to set, feeding itself from points nearer the gate little by little until fully set right up to the gate. If no liquid metal has been left entrapped, the casting will be reasonably sound. The designer of the work should, therefore, be in constant consultation with the foundryman so that between the two a construction may eventuate which will allow good feeding of the thicker portions, either through the gate or by filling the risers with fresh metal and "pumping" as long as may be possible.

As care is always taken to put the faces to be machined in the drag, the chance is taken that imperfect feeding may not be discovered. For quality work it is advisable to make a few castings from the pattern, break up the pieces, and study the fractures for open-grained points, shrinkages, measurements, and any other features that may be important.

Tunnel Kilns Used for Annealing Malleable Castings.

Scarcity of fuel of all descriptions is causing manufacturers to endeavour to conserve as much as possible, and to seek more efficient methods of heating. British ironfounders will be deeply interested in the recent developments of the continuous type of furnace described as the Tunnel Kiln, and more particularly in its application to the production of malleable castings.

Until lately all the tunnel kilns in the United States have been of the European type. Recently, however, the General Combustion Company, Chicago, has designed a tunnel kiln embodying new principles for annealing malleable-iron castings. The temperature requirements of this operation are very rigid to assure the requisite quality, and the tunnel kiln has turned out a finished product which is entirely satisfactory.

Its novel feature is that the kiln is composed of two tunnels side by side with a wall common to both. The stock progresses on cars through the two tunnels in opposite directions, and in each it moves opposite to the direction in which the burned gases are moving, to penetrate underneath the cars, which have an effective seal between them and the walls. Therefore, no elaborate method for cooling the bearings is necessary. Antechambers are used at both ends to prevent air from entering the kiln when cars are charged or discharged

The "American Foundry" describes a tunnel kiln plant which has been installed at the Saginaw Malleable Iron Company, by the American Dressler Tunnel Kilns, Inc., New York. While the use of tunnel kilns is entirely new to the malleable iron industry, similar kilns have long been in use for firing porcelain, and more recently for annealing steel.

In the operation of the kiln castings are packed into pots without packing material. The pots are placed on cars, which are charged into the furnace through an antechamber at regular intervals. The cars travel through the kiln in an opposite direction from that in which the gases of combustion are moving, although these gases do not come in direct contact with the cars or their charge. The cars continue on

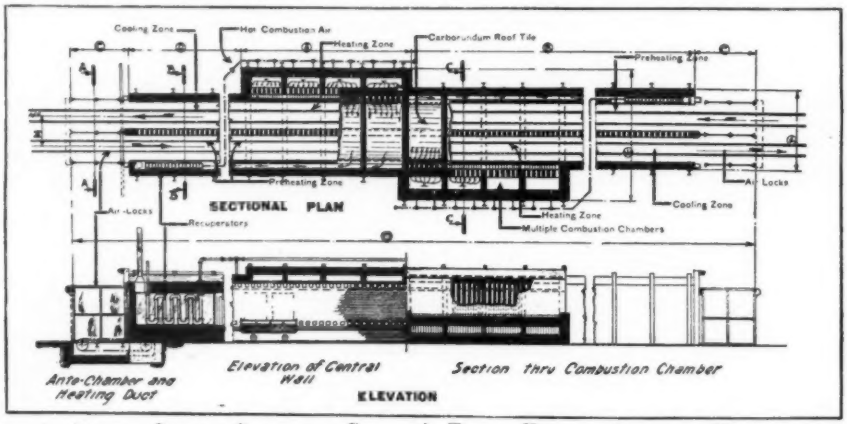

FIG. 1.—PLAN OF GENERAL COMBUSTION COMPANY'S TUNNEL KILN FOR ANNEALING MALLEABLE-IRON CASTINGS.

A plan of one of these units is shown in Fig. 1. This is accomplished by having the two firing zones placed diagonally opposite each other. A wall separates the flues of the two compartments. The products of combustion travel directly across the longitudinal axis of the kiln instead of parallel to it. A number of combustion chambers are provided. The burned gases pass through a flue along the entire length of the wall of the furnace and preheat the incoming air to be used for combustion. The air passes along the same chamber through a line of cast-iron pipes of special design.

The entrance end of one tunnel is beside the exit end of the other tunnel, and the wall between them is perforated at the top and at the bottom with a row of ports. With this arrangement the hot air from the annealed pots rises and passes through the upper ports to the chamber containing the cold incoming pots. Being cooled by these the air settles to the bottom portion of the chamber and is drawn through the ports at the bottom of the centre wall to the chamber containing the hot pots. In this way the hot material assists in heating the cool incoming charges and these in turn increase the cooling rate of the pots containing the annealed castings. The kiln is almost a perfect muffle and the charge is never subjected to the direct action of the flame. Little heat is allowed through the firing zone, where they attain the maximum temperature. They then pass to a portion of the kiln which is not heated except as to the walls and roof absorb heat from the hot pots. While passing through this zone the charge is gradually cooled. When the furnace is filled, a car passes out at the rear every time a new one is charged into the kiln. This outgoing car first enters an antechamber, from which it is drawn after the door between the antechamber and the main portion of the kiln is closed to prevent the admission of air into the kiln. The charge comes from the kiln too hot to be handled, so it is placed under a pipe through which air is blown on the hot charge until the next car comes from the oven. After the charge is cool enough to handle the pots are dumped A description of the construction of the kiln will aid in understanding the detailed process of annealing. A plan of the kiln is shown at the top in Fig. 2. This indicates the location of the burners on one side of the furnace. A duplicate set of burners is placed directly opposite to those marked. The cars enter at the left and travel in the direction indicated by the arrow. A cross section of the furnace is shown in the lower left-hand corner of Fig. 2. The combustion chambers *A*, *A* are formed by hollow refractory tile placed against each other, make a duct through which the burned gases are carried to the

exhaust. As the ducts are hollow, with openings at both the lower and upper inside portions, the gases of the kiln chamber enter the lower portion of the hollow tile, are heated by contact with the walls, and so rise through both the front and back leg of the tile, passing out through the apertures at the top. This action produces a constant circulation of heated gas in the kiln, so that the temperature is practically the same at the top as at the bottom of the kiln. The proper mixtures of refractories for the tile at the different portions of the kiln have been determined by the Dressler Company through many years of experience with porcelain burning kilns. Carborundum has been adopted for the tile at the hottest portion of the kiln. A layer of powdered silicious material is placed over the top of the furnace to conserve the heat.

The one end of the combustion chamber is at the exhaust and the other end, which is closed, is at the end of the firing zone farthest removed from the entrance of the kiln. Next to the combustion chamber there is a similar chamber which extends to the exit end of the kiln. This chamber acts

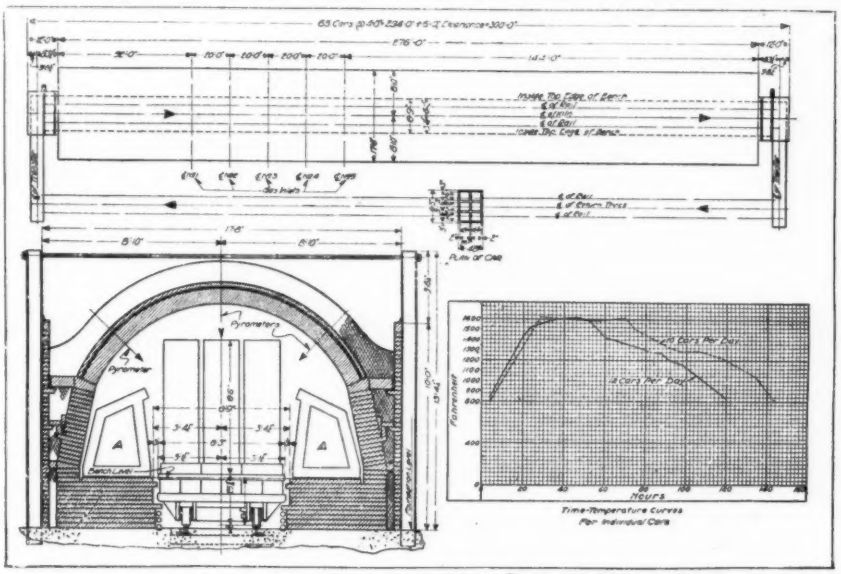

FIG. 2.—PLAN AND SECTION OF AN AMERICAN DRESSLER TUNNEL KILN.

oppositely from the combustion chamber, being adapted for carrying off the heat and thus cooling the pots more rapidly than they otherwise would be cooled. A pair of fans is provided on both sides near the exit end of the kiln, for drawing cool air through these ducts. However, so far the pots have cooled rapidly enough without the aid of the fans. Only one of each pair of fans would be required at a time to draw air through these ducts, but like all electrical equipment on the kiln a duplicate set is provided as insurance against accident or breakage.

A pair of fans also is used on each side of the kiln and at each end to draw air through pipes located in close proximity to the wheels of the cars which pass through the kiln. These pipes extend from both ends on each side to the middle of the kiln. They serve to prevent the temperature of the wheels from going above 700 deg. Fahr. Two fans draw the exhaust gases from the kiln through preheaters used to give the air blast an initial heat before it enters the combustion chamber. Another pair of fans blows the air for combustion through the burners. The kiln has 14 burners 7 on each side. These burners vaporise oil, which is taken to the burners under 12 lbs pressure, but drips from the oil pipe and is blown by air at a pressure of ¾ lb. A carbon dioxide recorder is used to determine whether the mixture of oil and air is correct to give complete combustion without an excess of air.

The temperature of the oven is watched carefully by the aid of 44 pyrometer couples located at different parts of the furnace.

The Saginaw Company states that the first cost of this kiln is somewhat higher than the cost of the number of periodic furnaces, which would be required to anneal the amount of castings annealed by the tunnel kiln. The length of time the kiln has been in operation is too short to determine the amount of saving in labour this method of annealing will effect over the periodic method. As at present operated three packers are required, three men load the stacks on cars, one man lutes the pots, and four labourers unload the annealed castings and place the empty pots, bases, plates and base boards on the conveyor. These men work one shift six days a week, but the six heaters work in two shifts seven days a week, three on a shift. The heaters put the cars in and out of the kiln, and one of them takes hourly temperature readings of the pyrometer couples. Besides this gang, part time of two truckers is required to carry the castings to and from the kiln and to move the cars. A kiln foreman has direct charge of the operation of the kiln, but does not supervise loading or unloading the cars, which duty is relegated to the labour foreman. When operating full with no delays, approximately 60 tons of castings are annealed each of the seven days in a week.

The advantages which the Saginaw Company find in the tunnel kiln are a shorter annealing time, which is cut from an 8-day cycle to a 5-day cycle, and a more uniform product. This latter is said to be marked. Then, too, owing to not using any packing material it is unnecessary to clean 80 per cent. of the castings, but this percentage can be shipped to the customer as they come from the kiln. The ability to anneal without packing is attributed to the almost neutral atmosphere in which the pots are kept during the anneal. This is accomplished because the kiln is almost a complete muffle with air excluded.

The Herbert Patent Sand-mixing Machine.

Engineering workshops in Great Britain have made great strides in recent years in the way of mass production, and the substitution of hand labour by machinery is a practice which is being extensively followed in every stage of manufacture, not excluding the foundry, where the use of moulding machines has rapidly grown.

FIG. 1.—THE HERBERT PATENT SAND-MIXING MACHINE.

The sand-mixing department of the foundry is one in which manual labour can be effectively substituted by machinery installations. As is well known, the quality of the sand for moulding purposes depends not only on the ingredients, but on the manner in which they are intermixed. It is also important that the sand should be thoroughly exposed to the air so as to allow all gases to escape, and to render it light and loose in texture and of even temper. The machine

FIG. 2.—HERBERT SAND-MIXING MACHINE AT THE EDGWICK FOUNDRIES.

was originally designed by Alfred Herbert, Ltd., for use in their own foundry.

This sand mixer consists of a pedestal carrying two vertical spindles rotating at a high speed one within the other. (See fig.). These spindles are driven in opposite directions by bevel gearing from a pulley on a horizontal shaft. The upper ends of the spindles carry two intermoving cages the bars of which passing each other in opposite directions at a great speed accomplish the mixing and disintegrating. The cages are covered by a dome-shaped casing, which directs the mixed sand on to the floor.

The centre of the dome carries a hopper into which the unmixed sand is fed, and from which it drops into the centre of the cages. The hopper can be lifted off for cleaning purposes. It is recommended that sand containing pieces of stone or iron should be screened before being deposited in the mixer.

The machine will deal with all the sand that two men can shovel, and from observations made it is computed that 7 cwt. per minute is a conservative estimate of its capacity.

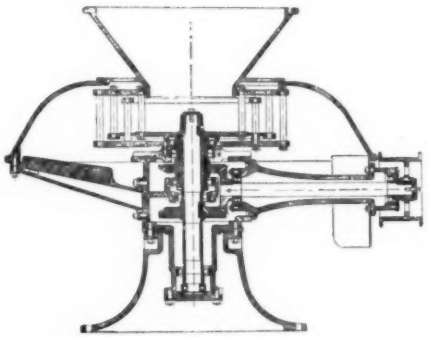

FIG. 3.—SECTION OF HERBERT SAND-MIXING MACHINE.

Considerable attention has been paid to the workmanship and finish of this machine, as it is very necessary that foundry equipment should be well designed, and to say the least, reasonably well finished. A point frequently overlooked is that man is very much influenced by environment, and a rough-looking machine is likely to receive rough treatment.

The machine described is constructed for long life and durability, the gearings and bearings being thoroughly protected from the entrance of dust or sand.

CASE-HARDENING COMPOSITION.—N. Taylor & Son, 17, Goree Piazzas, Liverpool, send us particulars of their hydro-carbonated bone-black for case-hardening. They point out that it is a fixed compound of definite composition ensuring uniformity of results. "Hydro-Carbonated Bone-Black" is very rich in carbon and free from any elements that are injurious to steel. It produces a very close grain, similar in appearance and effects to high-grade tool steel. It is simple and easy to use, operated in the usual manner, and adapted to work successfully with any make of furnace ensuring a uniform heat.

FOUNDRY SUPPLIERS' AMALGAMATION.—The Whiting Foundry Equipment Company, Harvey, Ill., and the American Foundry Equipment Company, New York, have consolidated, the new organisation to be known as the Whiting Corporation, capitalised at $5,000,000. J. H. Whiting, president Whiting Foundry Equipment Company, becomes chairman of the board, and V. E. Minich, president American Foundry Equipment Company and of the Foundry Equipment Manufacturers' Association, will be president. As the lines of manufacture of the component companies do not overlap, it is the intention to maintain all present manufacturing facilities. The Whiting plant at Harvey will retain the manufacture of cranes, cupolas, hoists, tumbling mills, core ovens, and all other items of the Whiting line, together with sand-blast equipment and dust arresters. Sand cutting machines, charging trucks, core machines and steel flasks will comprise the bulk of work at the new American plant at 2,935, West Forty-seventh Street, Chicago, under the direction of E. A. Rich, jun. Moulding machines, jolters, flask specialties and pattern mounting materials will continue to be manufactured at the York, Pa., plant of the American company, in charge of R. S. Buch.

Cores and Coreplates.

By James Edgar.

It is not my intention in this article to discuss the merits or demerits of the various types of boards referred to, or to compare the qualities of a coreboard with those of a corebox. Cheapness is very often the determining factor, although, apart altogether from cheapness, and considered purely from an efficiency standpoint, the coreboard has often much to recommend it. The purpose of this article will be served if it initiates apprentices and young journeymen into the

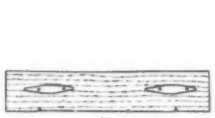

Fig. 1.

Fig. 2

various methods of sweeping up cores, which they may expect to see in different shops, and which, because of longstanding shop practice they may have to adopt even if they disapprove of them.

Fig. 1 is, perhaps, the commonest type loam board, and it is used when running up many kinds of horizontal cores on a spindle. Sometimes the pattern is made on the core, which necessitates the board being made to sweep the pattern diameters, and then a thick-

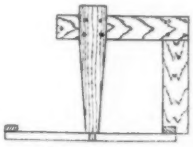

Fig. 3

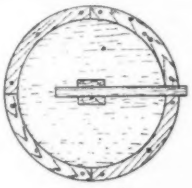

Fig. 4.

ness is screwed on the edge. After the core is made, the strip is removed and the thickness is swept on for the pattern. If such a pattern has flanges, they, of course, have to be made of timber and sprigged on. In shops where standard sweeping boards are made, it is customary to screw a strip of 'hoop" iron on the face along the sweeping edge, as the sand soon wears the timber. It will be noted that notches are cut in the edge to mark the length of core; sometimes nails are

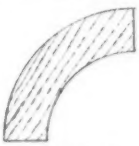

Fig. 5.

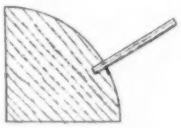

Fig. 6

used. The gauge strips on the face for calliper setting are preferable to cutting the edge of the board, or gouge—recessing it on the face, because they are easily removed to enable the board to be used for different diameters. The surplus length of horizontal boards depends upon the diameter of the core to some extent, but 12 ins. longer at each end is a fair average.

If it is wanted to sweep a plain circular core on a vertical instead of a horizontal spindle, because of its diameter being larger than its length, or for any other reason, a board like Fig. 2 generally answers the purpose. The two pieces of timber that comprise the boards are half-lapped. It is important that the top edge be planed so that the coremaker can use a spirit-level when bolting the board to the spindle arm. Two stoppers are screwed to the upright so that a gauge stick, fitting over the spindle, may be used. The ends of the gauge stick butt against the inner end of the stopper. A level can be used on the top of the board; one stopper is sufficient, but it is as well to make the board fool-proof.

For moderate-sized cores and often for large cores it is not left to the foundry to set the board, but a wood base plate and spindle are made (Figs. 3 and 4).

Fig. 7.

The spindle is usually turned, the top being left square. A segment about 1 in. thick is screwed on the plate. This is not always done, but it is good practice. In the examples shown the board revolves from the centre of the base plate, but occasionally a pin is turned on the top-end of the spindle and the board revolves on this. With regard to the edge which ought to be chamfered, it all depends upon whether the moulder will draw the board with his left-hand and feed the loam with his right, or vice versa. If the patternmaker does not know the foundry practice, or cannot consult the coremaker, it is wise to assume

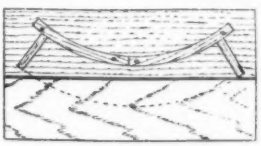

Fig. 8.

that the right-hand will be used for feeding, as this is the more general practice.

Cores for pipe bands are made in a variety of ways. Sometimes, although not very often, they are swept on the pattern joint. Fig. 5 is a very common board for bend cores. A half-core is made on each side, and the two halves afterwards "glued" together. The board is made 1 in. wider than the diameter of the core, so that the guide checks can be cut on the strickle (Fig. 7). A much better type of board is that shown at Fig. 6, because the core in this case can be made on an iron plate, which is better for

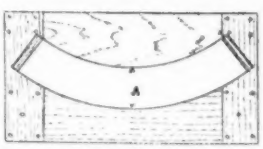

Fig. 9.

stoving, and there is no waiting for the first half-core to set before turning over the board. The board is clamped or weighted down, and the strickle, as shown in the sketch, bears against the edge. If a few cores are wanted, a more substantial plate or frame is constructed, similar to Figs. 8 and 9. The open frame is popular for the same reason that the plate Fig. 6 is popular, because the core is made on an iron plate. The frame is simply lifted over the half-core, when it is reversed, and the other half made. The strickle for such a frame is best made exactly a half diameter, and if the width of the core-shape (A, Fig. 9) is made an inch or more greater, it can be checked so that it bears on the iron plate The advantages of this over a runner such as must be

screwed on a plate is that it is not left to the moulder to finish the core afterwards. The frame need not be more than ¾ in. or ⅞ in. thick.

Cores other than circular can be strickled. Indeed, ingenious craftsmen will make the most unlikely cores with boards. Often a half-diameter core is wanted, similar to Figs. 10 and 11. A baseplate is first made, then a front board, which is kept vertical by the two brackets shown. The strickle, if large, would be made of two pieces of timber, half-lapped and

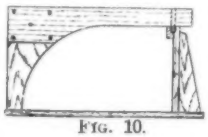

FIG. 10.

swinging on a pin. Frequently cores such as this have to be the thickness of a flange, and print greater than a half, in which case the pin is fitted the required distance from the vertical board. That part of the core which is beyond the centre can be formed easily by the moulder, who has the shaped front board as a guide.

The board illustrated by Fig. 12 is unique. Very often elliptical cores have to be made, and there is no reason why they should not be swept by a board

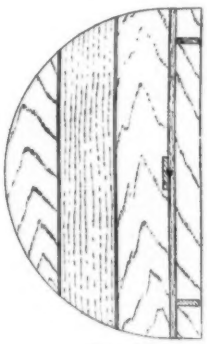

FIG. 11.

instead of being made in a box. The principle is the same as in drawing an ellipse with trammels. A base board and a central spindle with a turned pin on the top have to be made. The strickle has a slot cut in the top rail, so that the board adjusts itself as it is pressed against the edge of the base plate. It is, of course, necessary to have the spindle very firm, especially if the core is deep.

Valve and other branch cores are often made without a box. The fact that they fit, or "clip," as it

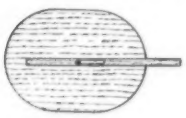

FIG. 12.

FIG. 13.

is termed, over a diameter or other shape does not matter. A piece may be screwed on the end ground (Fig. 13), to give the core the required shape. Fig. 14 shows a compromise between a box and a board. Plates are made corresponding to the shape of the core, and they are kept the correct distance apart by staves shouldered so that the plates cannot be knocked out. The core-maker would prepare a bed for the core, and use a straight-edge for strickling off.

When facings or internal rings have to be made in a core, it may be necessary, or at least advisable, to make a bridge piece A, Fig. 15, which, if large, would be built of segments. The facing in three or four pieces can be drawn into the bridge space after it has been withdrawn from the core. This method is applicable to either a plate or a frame. When bridge

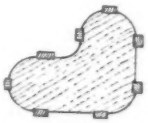

FIG. 14.

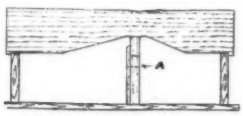

FIG. 15.

pieces like this are made the strickle has invariably to be made lengthwise.

Impossible boards are supplied occasionally to the foundry through ignorance. It is not good practice to attempt to sweep up an overhanging core. It would be hazardous, if not impossible, to make a core with a board like Fig. 16. Such a core ought to be

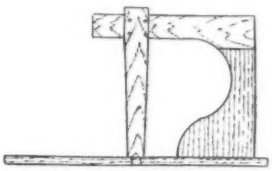

FIG. 16.

made partly by a box and partly by a board. Fig. 17 shows a section of a suitable skeleton box with a board guided by a segment on the top of the box, and swinging from a spindle. The box, which is square, is constructed of four sides, sufficiently deep that a circular centre-piece can be screwed to the bottom to

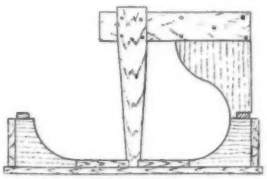

FIG. 17.

avoid feather-edged section pieces. Although not shown in the sketch, a better box is obtained by screwing a ¾-in. joint plate on the top of the section pieces, which should be fairly close together, and fitted between the sides of the box and the circular centre. Timber 1 in. thick is heavy enough for both the outside of the box and the section pieces.

BALL-BEARING HUBS.—A series of trials have been recently made for the purpose of demonstrating the advantages of ball-bearings for the hubs of vans and carts. The Skefko Ball-bearing Company, of Luton, were responsible for the trials which were carried out at Hendon Aerodrome and included tests relating to hill-climbing, starting, and weight of load with single- and pair-horse vehicles fitted with ball-bearing hubs, compared with similar vehicles fitted with the ordinary hub. The advantages of the new hubs were most pronounced perhaps in the starting-effort test. The greater ease with which the horses moved the loaded vans from their stationary position was confirmed by the weighted wire-rope test. It was clear that the saving of energy on the road, level or steep, was on a scale corresponding to the 30 per cent. economy in the measured starting test.

Testing of Foundry Sands.

In a recent issue of the "American Foundry" Messrs. H. B. Hanley and H. R. Simonds discuss the main characteristics which must be present in sands for various foundry purposes, and give detailed information as to the method of the determination of the relative value of these characteristics in different sands.

Bond Absorption Test.

All foundrymen realise the immense importance of the bond, and the details given of a reliable test for determining the extent of the bond are of considerable interest. This test consists of introducing crystal violet dye into a solution containing the colloidal matter of a sand sample. This dye has the peculiar property of being absorbed by colloidal substance in a definite and constant amount proportional to such substance. Thus a definite amount of colloidal matter is necessary to take up a definite weight of crystal violet dye After having obtained a solution of colloidal matter, the method of determining the weight of dye which it will absorb is briefly, as follows:—

Dye crystals gradually are added until after thorough mixing, a slight tint remains constant in the solution. This means that more of the dye has been added than can be taken up by the colloidal substance. The same tint which exists in the solution under test is then obtained by introducing a known amount of dye into pure water solution. The amount of dye absorbed by the colloidal matter then is the total weight of dye introduced into the solution under test, less the weight in a water dye solution having the same tint. Some inaccuracies develop in this test, due to the fact that suspended matter remains in the liquid containing unabsorbed dye, and this prevents an accurate tint comparison. A refinement of the test is possible, however, for the dye can be completely taken out of solution by mordanted cotton yarns.

It is safe to say that no other physical test gives so close an estimate of the quality of bond of a moulding sand as does this one of bond absorption. It provides an almost perfect means of comparing the actual quality of bonding material of one moulding sand with that of another. However, the test when used on widely different grades of sand is not infallible as ordinarily conducted. This is due to the fact that some colloids affect the absorption of dye stuffs from the solution in a different manner from others. Fortunately in the majority of cases this difference in effect is not sufficient to introduce a detrimental error. The amount of bond substance existing and the strength of bond of a moulding sand are, contrary to the general impression, not directly related, and it is this fact, more than any inaccuracies in bond absorption tests, which has introduced error into the work of many investigators. The bond itself is influenced by the surface area of the sand as a predominating factor. For instance, the bond test performed on a sample of sand, will indicate a definite quantity of colloidal matter present; yet the surface area of the sample may be low, if the sand is coarse, or may be high, if it is fine, and the bond will vary accordingly.

Imagine the total surface area of the sample, that is, the area of the surface of each individual grain, spread out and pieced together to form a flat surface. Such a surface made up from a coarse sand would be small, and from a fine sand, large. Therefore, if there is the same amount of colloidal matter to spread over one surface as the other, then it is obvious that the smaller surface will receive the thicker coating, which means that it would have a stronger bond. In other words, with a definite amount of colloidal matter present in a sand, the coarser the grain, the stronger the bond. This is true within ordinary limits. In a sand which is too coarse the effect of reduced contact area between the particles tends to counteract the increased bond density.

Results of the bond absorption test always must be linked with data concerning the grain size of the sand, otherwise the test is relatively valueless. This introduces the term, density of bond. The amount of colloidal matter divided by the surface area of a sand gives the bond density, and this furnishes a much more reliable guide to relative bond strength of sands than any other single quality.

An additional point to consider, irrespective of areas, is the shape of grains and the amount of void. The effect of variation in these qualities on the cohesion of sand particles in a mould can be determined to some extent through experience with different sands. The amount of void may be approximated from the results of a sieve test. Evenly graduated amounts remaining on the different sieves indicate a low void. That is, if a curve were drawn representing the amount of sand remaining on each successive sieve, a smooth line continually increasing or decreasing from the coarsest sieve to the finest sieve would show a sand to have far less void than an irregular line running up and down from one sieve to the next.

Transverse Test.

The bond absorption test is made by placing 25 grammes of the prepared moulding sand into a 500 cubic centimetre wide-mouthed bottle, and adding 250 cubic centimetres of distilled water, and 5 cubic centimetres of 10 per cent. ammonium hydroxide. The bottle, after sealing with a grass stopper and paraffin wax, is placed in a rotating machine for one hour. At the end of this period 140-cubic centimetres of distilled water are added, together with sufficient acetic acid to neutralise and leave an excess of acid. This usually requires 5 cubic centimetres of 10 per cent. acid. In this state the surface of each microscopic particle of the colloidal matter attracts or absorbs the dye. Sufficient dye is added to ensure a slight excess after the complete absorption. The bottle is then sealed and agitated in a rotating machine for two hours. After removing the bottle from the machine it is allowed to stand for a few hours, until the coarser particles have settled to the bottom. A beaker is then filled with 100 cubic centimetres of the top portion of the liquid, together with 25 cubic centimetres of water and 2 cubic centimetres of 10 per cent. acetic acid.

Removal of Dye.

While the beaker is seld at room temperature a 5-gramme skein of mordanted cotton yarn is introduced. The temperature is then gradually raised through a period of 40 minutes to 60 deg C., by which time, through careful movement of the skein, all the dyes should be removed from the solution, and the suspended matter from the moulding sand should be left behind. The skein is washed and dried at 75 deg. C., and a comparison of its colour against a standard set of skeins gives the amount of dye which has been taken from this solution. The usual arrangement of standard skeins is made by depositing on each of six skeins 6, 8, 10, 12, 14 and 16 milligrammes of crystal violet dye.

CORE BENCH WITH VIBRATOR ATTACHMENT.—A light, all-steel coremaker's bench with vibrator attachment developed by the Malleable Iron Fittings Company is described in a recent issue of the American "Foundry." The bench is rigidly constructed and is supported upon a reinforced table. The distinctive feature of the bench is that a rectangular space in the centre is taken up by a stiff plate having a vibrator attached directly to the bottom actuated by bearing down on the plate. In this way any small core box may be rammed on the plate, and by setting the vibrator in motion before lifting the box a clean draw is assured.

XUM

American Society for Steel Treating.

Many interesting papers were presented at Philadelphia at the recent annual convention of the new American Society for Steel Treating formed by the amalgamation of the American Steel Treaters' Society and the Steel Treating Research Society. The following are brief abstracts of some of these papers:—

A New Stainless Steel.

A Paper on the "Properties and Microstructure of Heat-Treated, Non-Magnetic, Flame, Acid, and Rust-Resisting Steel," presented by Mr. Charles M. Johnson, Director of Research Department, Crucible Steel Company of America, Pittsburgh, gave the results of a study covering a period of a year or more, originally with a view to producing a steel that could be forged, rolled, or sheared in thicknesses of 0.01 to 1 in. or more, and offering a maximum resistance to attack by oxy-acetylene flame; a steel that should be machinable as well as capable of permitting the drilling of holes. A steel has been produced which has unusual properties such as non-magnetic; rustless in water, fruit acids, glacial acetic acid, in 20-per cent. and 10-per cent. sulphuric acid, in 32-per cent. nitric acid, and in 19-per cent. hydrochloric acid. It has extraordinarily high reduction of area and elongation at temperatures which would burn anything but high-speed steels. As to resistance to flame, when attacked by the oxy-acetylene flame it requires 20 times as long to melt a hole through it as to melt one through ordinary steels.

Hardening Action of Nitrogen.

In a Paper entitled "The True Action of Cyanide in Casehardening Steel," prepared jointly by Mr. G. R. Brophy and Miss S. B. Leiter, metallurgists research laboratories, General Electric Company, Schenectady, N.Y., the authors published the results of their studies. They found that the nitrogen derived from cyanogen was responsible for a greater part of the hardening than was the carbon. Heretofore hardness had been thought to be due to the absorption of carbon from the cyanogen radical, the nitrogen aiding the penetration of the carbon. The authors gave particulars bringing out the fact that nitrogen caused great brittleness in steel by being absorbed during heating to a red heat in an atmosphere of ammonia, that it was absorbed in all metallurgical processes, and that it increased the strength of steel but diminished its ductility. Nitrogen embrittled to a greater extent than did carbon, as evidenced by tests on higher-carbon steels. Evidently carbon retarded the penetration of nitrogen.

Soft Spots in Casehardening.

Mr. Theodore C. Selleck, Alfred O. Blaich Company, Chicago, in his Paper on "Casehardening," pointed out that in surface carburising, soft spots caused a loss of materials, labour, fuel, and time. The most common causes of such spots were given as follows:—(1) Imperfect heating during the carburising periods due to improper distribution or overcrowding of boxes in furnaces. (2) Improper packing of parts in the boxes or pots. (3) The use of improper or imperfect containers; semi-steel, high-carbon steel and alloys of various kinds are better material for boxes than iron. (4) The use of poor imperfectly compounded carburisers. (5) The use of dirty carburisers.

The presence of sulphur in the carbonising material will eventually cause trouble and produce what is known as blue spots. The presence of sulphur, phosphorus, silicon, nickel and other elements in the steel in the form of segregation in such small areas that chemical analysis would not disclose their existence are also the cause of soft spots. Casehardening, after all, the author contended depended for its quality largely upon the steel itself. If imperfections existed in the steel they would be there after the metal was casehardened and would probably be intensified, if they were of the character that would not stand for the increased carbon content. Every improvement, therefore, in the manufacture of steel that tended toward the elimination of impurities and the uniformity of carbon content in it would materially aid the development of the carburising process.

Comparative Tests in Casehardening.

Mr. G. S. McFarland, metallurgist Jeffrey Manufacturing Company, Columbus, Ohio, in a Paper entitled "A Research in Case Carbonising," described tests on a 5-per cent. nickel steel, a carbon steel and a chrome-vanadium steel when used for case carbonising. The non-ferrous content of the carbon steel was:—Carbon, 0.22 · manganese, 0.50; phosphorus, 0.01; and sulphur, 0.03 per cent.; of the chromo-vanadium steel: Carbon 0.19; manganese, 0.57; phosphorus, 0.008; sulphur, 0.025; chromium, 0.74; and vanadium, 0.16 per cent; of the nickel steel: Carbon, 0.18; manganese, 0.51; phosphorus, 0.01; sulphur, 0.02 per cent.; and nickel 4.90 per cent.

A bar of each analysis of steel was turned down to § in. diameter, and nicked at suitable intervals to facilitate breaking after being hardened. The pieces were packed in a casehardening compound, placed in a suitable box and heated to a temperature of 1,650 deg. Fah., which was maintained for three hours; the bars were then allowed to cool slowly in the furnace overnight. The specimens were studied physically and microscopically in three conditions: (1) As they were when taken from the case-carbonising operation; (2) after being reheated to 1,425 deg. Fah. and quenched; (3) after being heated to 1,800 deg. Fah. and quenched, then reheated to 1.425 deg. Fah. and again quenched. Photomicrographs showed that the excess cementite in the carbon and chromo-vanadium steels had disappeared, but the structure was coarsened. In the nickel steel the structure was also somewhat coarsened. The double treatment increased the useful properties of the carbon and chrome-vanadium steels by toughening their cores, and decreased those of the nickel steel by weakening its core. The hardness of the "cases" was about the same with each steel. For ease in working, that is with a single heat treatment, and for higher physical properties, the nickel steel proved superior to the other two.

Deflectoscope.

An interesting device for detecting defects in various steel products, which was built on the principle of magnetic testing, was discussed by its inventor, Dr. Charles Burrows, formerly of the U.S. Bureau of Standards. By its use the determination of the quality of large quantities of steel of certain shapes was claimed as perfected.

Manufacture of Helical Springs.

In a Paper on "A Process for the Manufacture of Helical Springs for Heavy Duty," Mr. T. D. Lynch, research engineer, Westinghouse Electric & Manufacturing Company, dwelt upon the necessity of producing springs of the highest quality, and suggested the use of chrome-vanadium, silico-manganese, and chrome-molybdenum steel for use in making springs. Steel made by the crucible or electric furnace process was best for helical springs. The author described the making of a type of steel that he considered suitable for the making of helical springs, the composition of which was as follows: Carbon, 0.50 to 0.60; manganese, 0.60 to 0.80; phosphorus and sulphur, not over 0.04, and silicon 1.90 to 2.20 per cent.

ALLEN LIVERSIDGE, LIMITED, manufacturers of acetylene apparatus, propose increasing their capital from £100,000 to £300,000. It is stated that negotiations are in progress for the acquisition of another business.

Trade Talk.

BRISTOL INDUSTRIES, LIMITED, have taken over the business of the Bristol Foundry Company, Limited.

THE London office of P. and W. Maclellan, Limited, is now at Clutha House, 10, Princes Street, Westminster, S.W.1.

THE CROSBY VALVE AND ENGINEERING COMPANY, LIMITED, have removed to 41-2, Foley Street, Great Portland Street, W.1.

THE business of Mr. H. M. Budgett, Crown Works, Chelmsford, will in future be carried on by Messrs. A. E. and F. W. Windley.

A FIRE which broke out at the Tyne Iron and Shipbuilding Company's yard at Willington Quay destroyed several workshops.

ARRANGEMENTS for the Shipping, Engineering, and Machinery Exhibition, to be held at Olympia in the autumn of 1921 are now being made.

CONSIDERABLE damage has been caused by a fire at the works of John Kenyon & Company (Sheffield), Limited, steel manufacturers, Mill Sands, Sheffield.

THE BRIGHTSIDE FOUNDRY & ENGINEERING COMPANY, LIMITED, of Sheffield, have removed their Liverpool branch to larger premises at 242, Upper Parliament Street.

THE shareholders of Stewarts & Lloyds, Limited, have sanctioned the terms of the provisional agreement entered into with the directors of Alfred Hickman, Limited.

THE INTERNATIONAL CONSTRUCTION COMPANY, LIMITED, Prudential Buildings, Sheffield, have now brought their sales of the Morgan gas machine in Great Britain up to a total of thirty-four.

J. C. HILL & COMPANY, LIMITED, are stated to have acquired land on the Llandowlais Farm estate, at Cwmbran, with the intention of erecting new plant for an extension of their Oakfields Steel Wire Works.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, have purchased from the Chesterfield Corporation some 20 acres of land at Lockoford, upon which to erect premises for the manufacture of electric lamps.

MR. A. W. BAINBRIDGE has resigned his position as London representative of the Lanarkshire Steel Company, Limited, and has established himself in business at 63, Queen Victoria Street, E.C.4, as a steel and iron merchant, etc.

THE business of W. H. Spencer & Company, boilermakers, Hitchin, has been amalgamated with that of the Bonecourt Company, under the style of Spencer-Bonecourt, Limited, Parliament Mansions, Victoria Street, Westminster, S.W.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION have received a repeat order from Palmers Shipbuilding & Iron Company, Limited, for two Wellman mechanical gas producers with automatic feeds, each to gasify 30 cwts. of coal per hour.

THE shipbuilding output on the Clyde for the month of September was 23 vessels, with an aggregate tonnage of 57,753, as compared with 69,212 tons in September last year. The total tonnage launched this year is 464,791, against 403,190 in the first nine months of 1919.

MR. D. A. DANIEL has established himself in business as a metal merchant and broker, at 270, Gresham House, Old Broad Street, London, E.C. 2, under the style of Messrs. D. A. Daniel & Company. He was previously with Morrison, Kekewich & Company, Limited.

A COMPANY under the style of the Barrow Bolt and Engineering Company is opening out new works at Ramsden Dock, Barrow, very shortly, for the manufacture of bolts, nuts, rivets, railway spikes, etc. The proprietors are Mr. G. B. P. Thompson, Mr. H. G. Butchart, and Mr. F. Butler.

THE general meetings of the Institution of Mining and Metallurgy during the ensuing session have been fixed for the third Thursday in each month terminating in May, 1921, and will be held at the rooms of the Geological Society, Burlington House, Piccadilly, London, W1.

THE principal sales department of Pope's Electric Lamp Company, Limited, has been established at 5, Arthur Street, London, W.C.2, instead of at the works at Hythe Road Willesden. Stocks of "Elasta" lamps will be held at the new premises, where Mr. E. A. Marx (sales manager) is in charge.

THE Secretary of the Department of Scientific and Industrial Research announces that a licence, under Section 20 of the Companies' (Consolidation) Act. 1908, has been issued by the Board of Trade to the British Cutlery Research Association. The secretary of this Association is Mr. J. M. Denton, P.O. Box 49, Sheffield.

THE WOODWARD WEDDELL STEEL & ENGINEERING COMPANY, of Birmingham, have been formed for the production of tool steel in the electric furnace by a method patented by Mr. W. E. Woodward. Mr. Woodward claims that he can produce a steel suitable for ordinary workshop equipment at a cost considerably below that of tungsten high-speed steel.

MR. FARRELL, the president of the United States Steel Corporation, has stated that there is absolutely no foundation for the recent statements concerning the alleged plans of the Corporation abroad. All its foreign business was conducted by the United States Steel Products Company. Up to the present date no sales had been made to Germany of any class of material.

HOLLINGS & GUEST, LIMITED, Thimble Mill Lane, Birmingham, have during the last few months completed numerous export orders for their tyre presses, including destinations in India, China, South America, Spain, Portugal, Egypt, Ceylon, Sweden, Denmark, Holland, Belgium, Dutch East Indies, New Zealand, Turkey, Persia, Mesopotamia, Transvaal, Cape Colony, Roumania, etc.

WE understand that the firms of James Carmichael & Company, Limited, Ward Foundry, Dundee, and Alexander Hall & Company, Limited, shipbuilders and engineers, Footdee, Aberdeen, have come to an arrangement to amalgamate. Some time ago Messrs. Hall & Company contemplated the erection of a large new foundry in Aberdeen, but the lack of workmen and material was against that project, and the present arrangement decided upon in consequence.

THE LEEDS FORGE COMPANY, LIMITED, are instituting an apprenticeship scheme in collaboration with the Leeds Technical School, under which it is proposed to select, from about 300 apprentices, thirty of the most suitable for attendance at a half-time technical course, the lads being arranged in two classes of fifteen each, to attend full time in alternate weeks. The course will be specially arranged, covering the greater part of the year, and will be a combination of general education, engineering, science and workshop practice.

MESSRS CROSS, SON & ROBERTSHAW have been appointed sole selling agents for Wild-Barfield electric furnaces for the counties of Northumberland, Durham, Cumberland, and Yorkshire. In addition to their office in Newcastle, Messrs. Cross, Son & Robertshaw have opened a branch office at 41, Great George Street, Leeds, where a demonstration furnace is in course of erection. Messrs. Macbeth Bros. & Company, Limited, of Bombay and Calcutta, have taken over the sole selling rights for India, where these plants are already in operation.

THE New Zealand Government have accepted the tender of the North British Locomotive Company, Limited, for 25 railway locomtives at a cost of £12,350 each. Seven tenders for the contract were received from Great Britain, two from Canada, and

one from each of the United States, Germany, and Australia. Cammell, Laird and Company, Limited were the successful tenderers for 2,500 railway wagons, the price being £325 each. In this case there were four tenders, one each received from Great Britain and the United States, and one each from Canada and Germany.

THE prospectus has been issued of a new company known as the Onakaka Iron and Steel Company, Limited, formed for the purpose of acquiring from the New Zealand Ore Smelting and Manufacturing Company, Limited, their blast furnaces and steel furnaces and removing them to Onokaka, in the Nelson Provincial District, where limonite iron ore is to be found in abundance. The company has agreed to take up an under-lease for a term of 55 years of a property near Onakaka, belonging to Mr. T. A. Turnbull, of Nelson, who is one of the directors of the newly-formed company. This property contains 870 acres, and the company hope to obtain mining rights over certain adjoining premises.

During the progress of some experiments made by the Bureau of Ordnance, U.S.N., to produce suitable recoil springs from a lot of ¾-in. round silico-manganese spring steel numerous breakages were obtained in the 24-hour solid clamping test of the finished springs. In most cases the breaks showed deep seams. In torsion tests of the same material to determine the properties imparted by various heat treatments seams developed throughout the length of the specimen. As a torsion test would be an expensive procedure, it was decided to add a paragraph to the spring-steel specifications, requiring compression of a test piece of a length 1.5 times the thickness of the bar to a length equal to the thickness of the bar. This compression is sufficient to indicate clearly serious defects.

AT the annual meeting of the Bristol Wagon & Carriage Works Company, Limited, at Bristol, the chairman explained that the Leeds Forge Company, Limited, had acquired 97 per cent. of the issued share capital, and intended to reorganise the works and rebuild some of the shops to enable the carriage work required by the Leeds Forge Company to be carried out at Bristol. This reorganisation would involve considerable capital expenditure, and it probably would be necessary to call up the remainder of the capital at an early date. In order that none of the old shareholders should be prejudiced by the developments now taking place and the consequent calling up of the balance of the capital, the Leeds Forge Company had offered to buy out such shareholders at the rate of £12 10s. for each share of £10 paid.

THE Faraday Society, the Institution of Mechanical Engineers, the Institute of Metals, and probably also the Iron and Steel Institute, contemplate holding early in 1921 a joint general discussion on "The Failure of Metals under Internal or Prolonged Stress." While various aspects of the subject have already been discussed, some new matter will be placed at the disposal of the co-operating Societies, and it is considered that this will afford an opportunity for a more comprehensive consideration of the subject than has yet been given to it. The problem to be discussed is the failure of metal articles as a result of external stresses to which they have been exposed for any length of time, or of internal stresses arising from conditions of manufacture, such as cold work, unequal expansion or contraction during casting and subsequent operations including rapid heating and cooling. It is intended that the subject of the discussion should include the phenomena known as "season cracking," "corrosion cracking," "fire cracking," and analogous forms of failure, and that iron and steel as well as non-ferrous metals should be dealt with.

THE s.s. "Cortona," a double reduction gear turbined vessel, built and engined by Vickers, Limited, at their Naval Construction Works, Barrow-in-Furness, for the Donaldson South American Line, was recently launched. She represents the latest and most fully equipped type of vessel for the South American trade, and is an acquisition to the British merchant service. In the construction of this vessel consideration has been given to the general cargo trade requirements from Glasgow and Liverpool, and the vessel has all the facilities for the speedy handling of the usual assortments of cargo for South America. The leading particulars of the "Cortona" are: Length, 44 ft. between perpendiculars; breadth (moulded), 55 ft. 6 in.; depth (moulded), 39 ft. 3 in. to shelter deck; loaded displacement, 13,120 tons; deadweight carrying capacity, 9,100 tons. The vessel has been designed to develop a speed of 12½ knots, and her fuelling arrangements are such that she can burn either coal or oil. Twenty derricks are fitted to serve the five main hatches, twelve of which derricks are capable of dealing with lifts of 3 tons each, seven of 7 tons each, and the remaining one of 10 tons.

Mr. E. W. Fraser Smith, secretary of the North-East Coast Institution of Engineers and Shipbuilders, has issued the syllabus of papers as at present arranged for the forthcoming winter, from which it will be recognised that an important session's work has been undertaken, the following papers will be contributed: "Some Experimental Work in connection with the Injection and Combustion of Fuel in Diesel Engines," by Engr. Commander C. J. Hawkes; "Naval and Maritime Hygiene in relation to Shipbuilding," by Surgeon-Admiral Sir Robert Hill, Director-General of the Naval Medical Service; "The Relation between Shipbuilding Production, Prices and the Freight Market," by Mr. Maxwell Ballard; "Advantages of Water-tube Boilers in Merchant Ships," by Sir James Kemnal; "Fuel Oil," by Mr. W. A. White; "Steam Action in Simple Nozzle Forms," by Dr. A. L. Mellanby; "Marine Diesel and Marine Oil Engines," by Mr. K. O. Keller; "Organisation for Ship Production," by Mr. W. Ayre; and "Construction of Submarines," by Mr. H. G. Williams. The annual meeting will be held on October 29 next, when Mr. Doxford will deliver his address. It is hoped to resume the annual conversazione and the annual dinner.

The American Institute of Weights and Measures does not favour the metric system, declaring that the metric system of weights and measures has made little progress in the industries of the United States. The facts indicate that the nearest approach to world uniformity in manufacture and trade has been achieved by non-metric England and America. The overwhelming preponderance of British and American foreign and domestic trade and the dominating position held by their system of weights and measures in every commercial port have secured for them a universality through natural processes, which no amount of compulsory legislation could have made possible. We have only to remember, among other things, that:—(1) 70 per cent. of the world output of steel is manufactured in the United States and Great Britain on the inch and pound basis. (2) About two-thirds of the world production of machine tools is made to the inch. (3) 80 per cent. of the world production of screw threads is made to the inch. (4) The United States manufacture 90 per cent. of the world production of motor vehicles. (5) The standard unit by which timber is measured the world over is the board-foot, being a board one foot square by one inch thick. (6) About two-thirds of the commerce of the world in manufactured products is on the basis of the English-American system of weights and measures

How closely the problem of unemployment and the possibilities of obtaining almost immediate amelioration in the serious situation which is rapidly developing is interwoven with the plea for a definite period of industrial stability to facilitate the acceptance and carrying out of large contracts in every industry in the country, was emphasised at a conference held under the auspices of the Industrial League and Council to study this particular question at the private residence of Mr. H. Hirst, of the General Electric Com-

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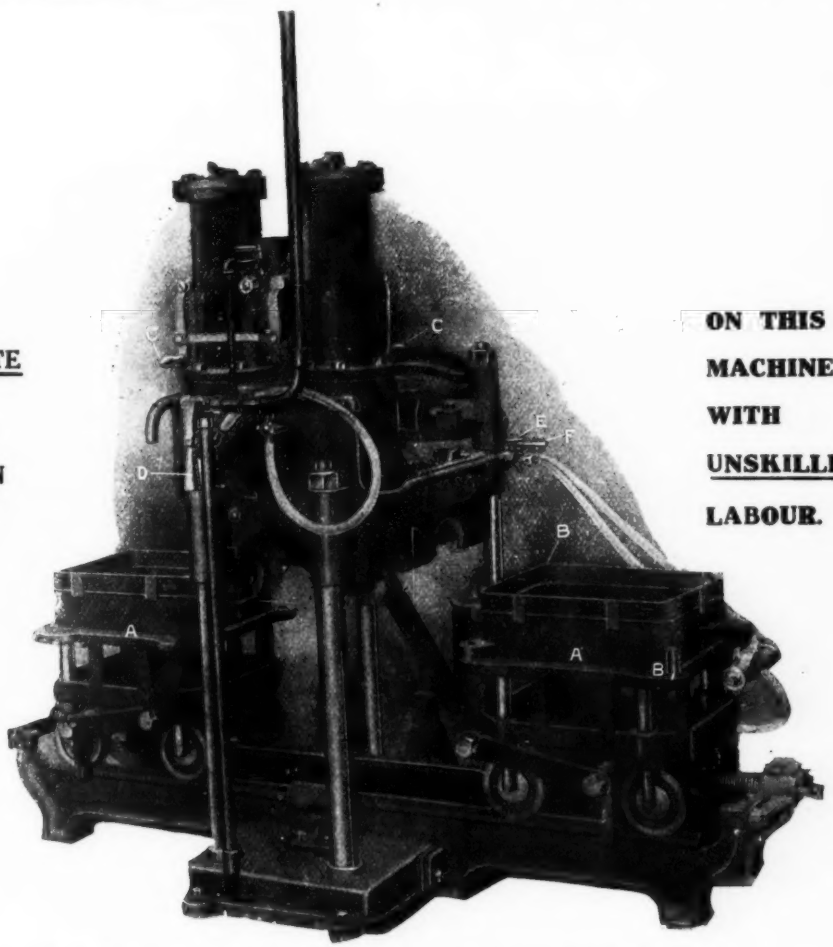

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pany, Limited. Those who took part in the conference were, in addition to Mr. H. Hirst, the Rt. Hon. G. H. Roberts, M.P., the Rt. Hon. R. McKenna, Major-General Sir Newton Moore, M.P., Mr. E. W. Petter (Vickers-Petters, Limited), Mr. David Gilmour (Scottish Miners), Mr. E. Manville, M.P., Mr. J. Baker (Iron and Steel Trades' Confederation), Mr. J. D. Boving (Boving & Company, Limited), Dr. A. H. Railing and Mr. M. Railing (General Electric Company, Limited). Mr. P. Rosling (W. T. Henley's Telegraph Works Company, Limited), Mr. F. Smith (Shipbuilding Trades' Federation), Mr. C. Wilson (Osram Lamp Company), Mr. J. Hall (Iron and Steel Trades' Confederation), and others. The discussion was opened by Mr. E. W. Petter, who said that employers, not knowing from one day to the next what new demands would be made upon them, were unable to give firm prices to contracts or even a definite date for delivery, and the result had been that contracts valuing in the aggregate millions of pounds had been taken from England and placed abroad. He cited concrete instances of contracts which had been lost to this country through the causes mentioned, and the ultimate result was being reflected more and more by the condition of the labour market. Large employers who had ventured to state fixed price in contracts found, when the contracts had been completed, they had lost thousands of pounds in the transaction. They could not afford to go on doing that. If they could only agree to stability for a fixed period, approximately twelve months, during which time all should agree to carrying on under existing standards, he had no hesitation in saying the outcome would be that the wave of unemployment would be obviated, industry would speedily recover and absorb the whole of the unemployed in the land, the cost of living would be automatically and materially decreased, and at the end of the year the workers, providing they stuck conscientiously to their work, would find they would be able to maintain not only their present rate of pay, but its relative value would be considerably enhanced as the value of the pound would be brought considerably nearer to an economic level.

THE fourteenth meeting of the Executive of the Engineering Training Organisation was held recently at the Institution of Civil Engineers, Sir William Ellis in the chair. Mr. J. E. Richmond, representing the Engineering and the National Employers' Federations, and Mr. W. Prescott, representing the Federation of British Industries, were present by invitation. The chairman, in welcoming the representatives of the E.E.F. and the F.B.I., explained that their respective Federations had each offered to take over the work of the E.T.O., and that the E.T.O. executive had been authorised to discuss the question with them in all its bearings, and to act definitely and finally upon its decision. The question to be determined, therefore, was whether the objects for which the E.T.O. was formed would be furthered better by the E.E.F. or the F.B.I. Mr. Richmond, in outlining the position of the Engineering and the National Employers' Federations in relation to engineering training, first expressed the Federations' appreciation of the value of the work already accomplished by the E.T.O., and then proceeded to give reasons why the Federation had volunteered to carry it on. Chief among these was the increasing frequency and greater importance of training questions in the agenda of the Federation's conferences with Labour. This condition was not one of choice, but of necessity, for the Federation's burden of ordinary work was far too heavy to leave time or energy for the consideration of non-essential problems. Mr. Prescott, speaking for the F.B.I., explained that it had always been the policy of their Educational Section to abstain from direct participation in the details of training in any industry that had established, or was willing to establish, an efficient representative body for that purpose. Acting on this principle, they had recognised the E.T.O. as representing the engineering industry, and were prepared similarly to recognise the E.E.F. The appreciation of the F.B.I. for the work accomplished by the E.T.O., and the sense of their own responsibility towards the engineering industry was such, however, that they felt bound, in the first instance, to express their willingness to carry it on if asked to do so, and, in the second place, to stand aside when, but only when, they felt satisfied that the work would be properly done by someone else. As Mr. Richmond had given the necessary assurances, Mr. Prescott expressed every willingness to accept them, and to welcome a decision by the executive in favour of accepting the offer of the E.E.F. to carry on the E.T.O. work. After discussion, the executive decided to accept the offer of the E.E.F., and authorised Mr. Berriman to carry out all details of the transfer.

Personal.

THE late Mr. W. Rogers, engineer, of Loughton, Essex, left £23,181.

THE late Mr. E. Litherland, retired metal merchant, of Edgbaston, left £7,492.

THE LATE MR. R. PAYNE, consulting engineer, of 62, London Wall, E.C., left £9,493.

THE late Mr. R. Barber, steel merchant, Sheffield, left estate valued at £11,013 gross.

MR. J. W. MURRAY, of Glasgow, has been elected a director of the Caledonian Railway Company.

THE late Mr. Joseph Adamson, engineer, of Oaklands, Godley, near Hyde, Chester, left £80,497.

ESTATE of the gross value of £19,896 has been left by the late Mr. W. Sheldon, engineer, of Leeds.

MR. S. M. WILFORD has been elected a special director of W. H. Dorman & Company, Limited, of Stafford.

THE LATE MR. H. EVANS, for 14 years chief goods manager to the Midland Railway Company, left £15,624.

ESTATE of the gross value of £20,041 has been left by the late Mr. A. E. Bennett, engineer, of Redlands, Toller Road, Leicester.

THE gross value of the estate of the late Mr. J. Metcalfe, of Davies & Metcalfe, Limited, engineers, Romiley, Cheshire, is £29,279.

THE late Mr. E. Parry, a director of the Midland Railway Carriage & Wagon Company, Limited, left £33,977, with net personalty £33,831.

MR. J. CALDWELL, deputy chairman of Industrials, Limited, has retired from the firm of James E. Sayers & Caldwell, consulting engineers, Glasgow.

MR. E. F. MERRETT has been appointed manager of the Carriage and Wagon Works at Newton Heath, of the Lancashire & Yorkshire Railway Company.

THE late Mr. H. M. Gray, of the Leys Malleable Castings Company, Limited, left estate of the gross value of £77,258, with net personalty of £68,088.

THE late Mr. O. T. Orr, engineer and brassfounder, of Greenock, left personal estate of the total value of £8,958, of which £8,871 is in the United Kingdom.

MR. E. R. FORESTER, of Forester & Company, iron and steel merchants, Swansea, who died in March last, left estate of the gross value of £26,029, with net personalty £16,172.

THE late Mr. E. H. Williams, iron merchant, of Whitchurch, Cardiff, a director of Cross Brothers, Limited, left estate of the gross value of £5,515, with net personalty £4,900.

MR. G. HARDING, engineer, of Oxton, Cheshire, of Messrs. C. S. Wilson & Company, who died on June 11, left estate of the gross value of £175,204, with net personalty £174,361.

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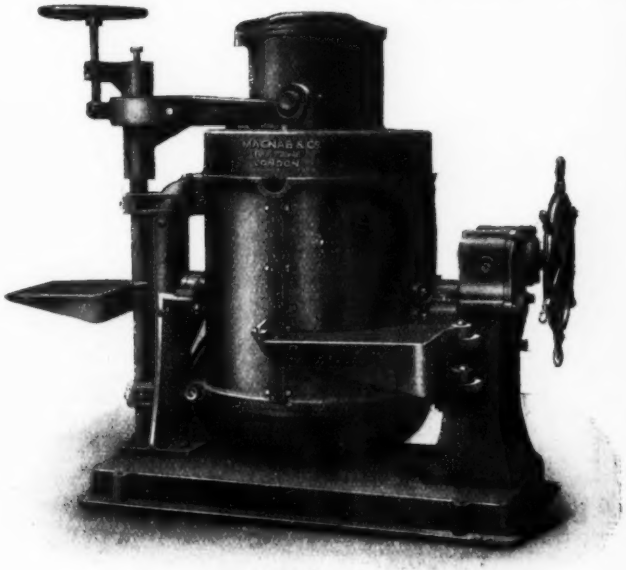

Tylor Patent Pit-Type Furnace.

OUTPUT.

200 lbs. Admiralty Gunmetal melted in 35 minutes. Temperature 2000° F.=1093° C.

ECONOMY.

25 lbs. of Coke used per 200 lbs. of Metal melted.

STANDARD CRUCIBLES.

Lasting 35 to 40 heats.

Tylor Patent Tilting-Type Furnace.

OUTPUT.

400 lbs. Admiralty Gunmetal melted in 50 minutes. Temperature 2000° F.=1093° C.

ECONOMY.

80 lbs. of Coke used per 450 lbs. of Metal melted.

STANDARD CRUCIBLES.

Lasting 30 to 40 heats.

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Works: TOTTENHAM, LONDON, N.17.

DR. O. S. SINATT, at present lecturer in mechanical engineering, London University, has been appointed to the Professorship of Aeronautical Science at the Royal Air Force Cadet College, Cranwell.

THE late Mr. C. H. Hands, managing director of John Hands & Sons, Limited, and chairman of the ironfounders' section of the Engineering and National Employers' Federation, left £3,679.

MR. W. R. BURCH has resigned his seat upon the board of the Hume Pipe Company, Limited, and Lieut.-Colonel C. L. Andersson and Mr. A. J. Wright have been elected directors of the company.

MR. R. TRAILL, a director and one of the managers of the Wallsend Slipway and Engineering Company, Limited, has been elected a director and engineering manager of the Fairfield Shipbuilding and Engineering Company, Limited.

MR. A. M. KENNEDY, who has been elected president of the Shipbuilding Employers' Federation, is managing director of the Northumberland Shipbuilding Company, Howden-on-Tyne, of the Fairfield Shipbuilding and Engineering Company, Govan, and of the Monmouth Shipbuilding Company, Chepstow. He is also prominently connected with William Doxford & Sons, Limited, Sunderland, Workman, Clark & Company, Limited, Belfast, and one or two of the other Sperling industrial enterprises.

MR. H. L. REASON, M.I.Mech.E., M.I.M., after occupying for nearly ten years the position of manager to John Russell & Company, Limited, the Belmont Works, New Spring Street, Birmingham, brassfounders, has resigned in order to become general manager to United Brassfounders & Engineers, Limited, at their works, Holloway Head, Birmingham. Mr. Reason has been twice president of the Birmingham Branch of the Institution of British Foundrymen, namely, from 1911-1913, and for the session 1919-20, and at the Annual Convention in Glasgow, in August last, was elected a vice-president of the Institution. He has contributed a variety of interesting and practical papers not only to this Institution, but also to the Birmingham Metallurgical Society, the Birmingham Local Centre of the Institute of Metals, and other societies of which he is a member. On his initiative the Institution of British Foundrymen took an active part in bringing about the formation of the British Grey and Malleable Cast-Iron Research Association, and he is now the representative of the Institution on the Council of the Association. Mr. Reason has also done valuable work for the British Standards Association, in connection with copper pipes, screw threads, unions, and pipe-fittings for copper pipes. On Saturday, October 2, Mr. Reason was entertained at a farewell dinner and concert at the Crown Hotel, Station Street, Birmingham, when about 200 of the staff and workpeople of John Russell & Company, Limited, attended, and he was presented with a gold cigarette case, suitably engraved.

MR. CHARLES HEGGIE, who was for some time hon. secretary of the Birmingham Branch of the Institution of British Foundrymen, and afterwards President of the Branch, has left the firm of John Wright & Eagle Range, Limited, with which he has been associated in a managerial capacity for seventeen years and has become managing-director of Patterns, Limited. On Friday, October 1, at the Swan Pool Hotel, Aston Manor, Mr. Heggie and his wife were the guests at a dinner given by the members of the staff and workpeople of John Wright & Eagle Range, Limited. Mr. W. Morrison, departmental manager, presided, and, in proposing the health of Mr. and Mrs. Heggie, spoke of the excellent terms upon which Mr. Heggie had lived with the staff and workpeople, and wished him every success in his future career. Mr. F. E. Robinson, in asking the acceptance by Mr. Heggie of a gold watch, accompanied by a diamond ring for Mrs. Heggie, joined in the good wishes expressed by the chairman, and spoke in eulogistic terms of the services of Mr. Heggie to the firm, and of the happy relations he had enjoyed with all his colleagues. Mr. Adnett (head of the tool room) heartily endorsed the remarks of the chairman and Mr. Robinson, and it was announced that the firm had presented Mr. Heggie with a handsome cheque as a mark of their appreciation of his services.

Deaths.

THE death has occurred of Mr. George Tangye, one of three brothers who founded the famous engineering firm of Tangyes, Limited.

THE death occurred on September 30, at 83, Crouch Hill, N., of Mr. J. Boyd, formerly of Glasgow, and founder of the British Asbestos Company. He was 79 years of age.

THE death has occurred of Mr. Henry Steel, chairman of the United Steel Company and of Messrs. Steel, Peech, and Tozer, and a director of several other important firms.

MR. J. EDGE, who recently died at Shifnal, Shropshire, in his 83rd year, was managing director of Edge & Sons, Limited, ironfounders, etc., Coalport Works, Shifnal, a firm founded by his grandfather over 100 years ago. He was also a director of the Aldridge Colliery Company, Limited.

THE death has occurred in Glasgow of Major D. T. Jenkins, V.D., who since 1915 had been manager of the Glasgow Iron and Steel Company's works at Wishaw. Aged 62 years, Major Jenkins was a son of the late Mr. T. Jenkins, J.P., Dowlais, and for over a quarter of a century prior to his departure for Wishaw he was the head of the steel department at Messrs. Guest, Keen & Nettlefolds' works in Dowlais.

THE death has occurred suddenly of Mr. E. G. Kirkhouse, of Jesmond, Newcastle, and formerly of West Bank, Consett, at the age of 59 years. Having gone from South Wales to Consett over thirty years ago, the deceased gentleman became manager of the blast-furnace department at the Consett Iron Company's works, in succession to the late Mr. George Ainsworth, who had received the appointment of general works' manager. He relinquished the post owing to the state of his health within the last twelve months, and was the recipient of a handsome presentation from the officials and men.

THE RIGHT HON. SIR WILLIAM MATHER recently died after short illness at Bramble Hill Lodge, New Forest. Born in 1838, he was educated privately and in Germany. Although leading a strenuous political life, it was as a practical, far-seeing business man that Sir William Mather made his mark. On completing his educational course he entered the Salford Iron Works, owned by his father in conjunction with Mr. Platt, and at the age of 24 he was taken into partnership. In 1871 he was entrusted with the entire management of the rapidly growing concern, and in 1877 he became sole proprietor, on the retirement of the elder partners. In 1892 the firm of Mather & Platt was converted into a limited company, with Sir William as chairman, and in 1899 it was reconstructed to permit of amalgamation with Dowson, Taylor & Company, Limited. In 1893 he established the eight-hour day throughout his works, well in advance of other manufacturers. Another direction in which Sir W. Mather was a pioneer was in giving advantages to his apprentices, and it was a strict rule that every apprentice at the works should attend the evening class unless he was a student at one of the public technical schools which afterwards supplemented private enterprise. His enthusiasm in that respect, and for education generally, was shown by his work as a member of the Council of Owens College and Victoria University, and his investigation of technical education in America and Russia for the Royal Commission of 1883. He was a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers and the Iron and Steel Institute.

Telephone: 21, Penistone. Telegrams: "Durrano, Penistone."

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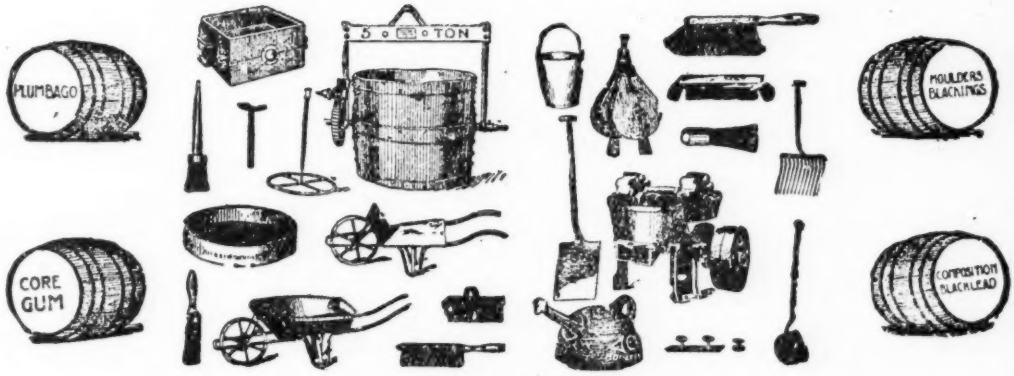
JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



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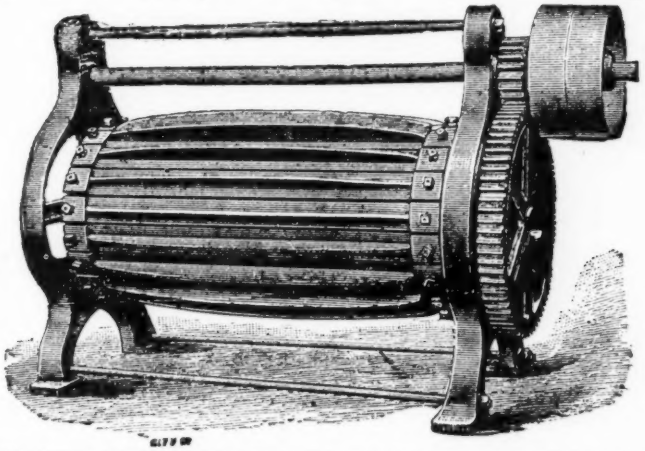
Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

New Companies.

Western Iron Works, Limited.—Capital £50,000 in £1 shares.

Woodfield Engineering Company, Limited. — Capital £10,000 in £1 shares.

Birmingham Foundries, Limited.—Capital £5,000 in £1 shares. Registered office: 63, Charles Henry Street, Birmingham.

Blade Lock Nut Company, Limited.—Capital £10,000 in £1 shares. Registered office: B.16, Queen Insurance Building, 10, Dale Street, Liverpool.

Welders, Limited.—Capital £5,000 in £1 shares, to carry on the business of metal welders at Hull. Directors: T. Shipley and A. Garton.

Lowth & Smith, Limited.—Capital £5,000 in £10 shares, to carry on the business of engineers. Registered office: 3, Hanging-ditch, Manchester.

S. H. Flood & Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of engineers. Registered office: 103, Cannon Street, London, E.C.

John Lawton & Sons, Limited.—Capital £15,000 in £1 shares, to carry on the business of ironfounders. Registered office: 30 and 31, Harford Street, Birmingham.

Diamond Engineering Company, Limited. — Capital £2,000 in £1 shares, to acquire and carry on the existing company. Registered office: Grahamston Station, Falkirk.

Rockwood Company, Limited.—Capital £5,000 in £1 shares, to carry on the business of pressed steel manufacturers, etc. Registered office: 147, Queen Victoria Street, E.C.

Douglas Campbell, Limited. — Capital £600 in £1 shares, to carry on the business of manufacturers of machinery, etc. Registered office: 59, Chancery Lane, London, W.C.2.

Modern Woodworking Machines, Limited. — Capital £6,000 in £1 shares. Directors: A. Bailey and H. D. Gandy. Registered office: Crown Works, Newfound Pool, Leicester.

Tofts & Cooper, Limited. — Capital £20,000 in £1 shares (10,000 preferred), to carry on the business of engineers. Registered office: 13, High Street, Halstead, Essex.

Currie, Meredith, Limited. — Capital £1,000 in £1 shares, to carry on the business of mechanical and consulting engineers. First directors: H. C. Currie and J. Meredith.

Birmingham & Staffordshire Electrical Company, Limited.—Capital £3,000 in £1 shares (1,000 founders). Registered office: Post Office Buildings, Samuel Street, Bloxwich, Staffs.

Sidney Smith & Blyth, Limited.—Capital £6,000 in £1 shares (2,000 preference), to carry on the business of ironfounders, etc. Registered office: 35, Garratt Lane, Wandsworth, S.W.

Palmer & Kaneen, Limited. — Capital £1,500 in £1 shares, to carry on the business of shipsmiths, shipwrights, ironfounders, etc. Registered office: 45, Bridgewater Street, Liverpool.

John Lang & Sons (Blackburn), Limited. — Capital £8,000 in £1 shares, to carry on the business of ironfounders. Registered office: Blakewater Foundry, George Street West, Blackburn.

Herbert Gill & Company, Limited.—Capital £7,000 to carry on business as cutlery manufacturers, tool makers, etc. Directors: P. Turner and F. Botham. Registered office: 13, Arundel Lane, Sheffield.

Pickering's Spring & Saw Company, Limited. — Capital £3,000 in £1 shares, to adopt an agreement with J. H. Hanson and F. C. G. Pickering, trading as Pickering's Spring & Saw Company.

French Chains, Limited.—Capital £40,000 in £1 shares, to adopt an agreement with the Coventry Chain Company and Dubied et Cie. Registered office:—199, Piccadilly, London, W.

Park Steel Company, Limited.—Capital £2,000 in 10s. shares. Directors, W. E. P. Bowie (chairman), J. Anderson, D. J. K. Thorn, and F. W. J. Bowie. Registered office: 12, Mowbray Street, Sheffield.

ATLAS DIESEL CO. LTD.

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CHIPPING HAMMERS. SCALING HAMMERS. HOLDERS-ON. YOKE RIVETERS.
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All sizes, Vertical and Horizontal. Air and Gas Receivers, any capacity.

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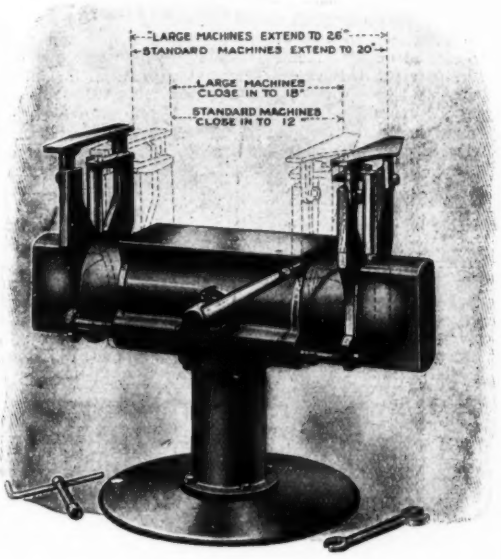
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MOULDING MACHINES,
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SAND MILLS,
CUPOLAS,
HOISTS,
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Federated Engineers, Limited.—Capital £1,000 in £1 shares, to carry on the business of engineers. Directors: F. E. Jones and J. Groom. Registered office: Norfolk House, Laurence Pountney Hill, London, E.C.

Ayrshire Foundry Company, Limited.—Capital £5,000 in £1 shares, to acquire the business of Ernest Middleton at 35, King Street, and at the Wallacetown Foundry, both in Ayr. Registered office: Limond's Wynd, Ayr.

Herbert & Sons (Scale Makers), Limited. — Capital £5,000, to take over the business carried on at 319 and 321, Gray's Inn Road, King's Cross. Directors: W. A. Herbert, W. A. Herbert, jun., and T. J. Herbert.

Petrel Engineering Company, Limited. — Capital £5,000 in £1 shares, to take over the business carried on at 26, Rea Street South, Birmingham, as the Petrel Engineering Company. Registered office: 26, Rea Street South, Birmingham.

Henry Osborn, Limited.—Capital £15,000 in £1 shares (5,000 10 per cent. cumulative preference), to take over the business of tool merchants carried on by Elizabeth A. Osborn and S. Osborn at Westgate Road, Newcastle-on-Tyne, as Henry Osborn.

Keep's Construction Company, Limited. — Capital £10,000 in £1 shares, to take over the business of tank makers and ironplate workers carried on at Barn Street, Birmingham, as Keep & Company. Registered office: 13, Barn Street, Birmingham.

Arkinstall Brothers, Limited.—Capital £12,000 in £1 shares, to take over the business of galvanisers and ironplate workers carried on at Coventry Street, Birmingham, by Arkinstall Brothers. Registered office: 38, Coventry Street, Birmingham.

British Rolling Mills, Limited.—Capital £50,000 in £1 shares, to take over the business of the British Rolling Mills, Limited (in voluntary liquidation), carried on at Cliveland Street, Birmingham. Registered office: 16, Cliveland Street, Birmingham.

Institute of Patentees (Incorporated).—Management vested in following council:—I. Darby, H. E. Dakin, Capt. L. T. Elias, A. G. Hardcastle, S. M. Johnson, M. Morgan, and G. H. Skinner. Organising secretary: G. D. Coleman. Registered office: 6, Holborn Viaduct, E.C.

Tools, Limited.—Capital £3,000 in £1 shares, to take over the business carried on at 15a, Steelhouse Lane, and 246, Bell Barn Road, Birmingham, as Gill, Bodenham & Company, and Victoria Machine Tool Company. Registered office: Prudential Buildings, Corporation Street, Birmingham.

William Heywood & Son, Limited.—Capital £10,000 in £1 shares, to take over the business of ironfounders and general engineers carried on by Messrs. W. Heywood and L. Heywood, at Royton, as William Heywood & Son. Directors: W. Heywood, L. Heywood, W. Tattersall and H. Lowe.

Alfred F. Genton, Limited.—Capital £6,000 in £1 shares, to carry on the business of manufacturers and factors of ships' and railway lamps and general brass and iron foundry ships' fittings, etc.; to adopt an agreement with A. F. S. Genton. Registered office: Bingley Works, King Edward's Place, Birmingham.

William Elliott & Sons, Limited.—Capital £6,000 in £1 shares, to acquire the business of an engineer and boiler maker carried on by W. Elliott at Crocus Street, Nottingham, as William Elliott. Directors: W. Elliott (permanent), A. M. Elliott, and P. J. Elliott. Registered office: Boiler Works, Crocus Street, Nottingham.

United British Manufacturers, Limited. — Capital £10,000 in £1 shares, to carry on the business of supplying to Russia and other countries goods manufactured by Spear & Jackson, Limited, of Sheffield; B. R. Rowland & Company, Limited, Reddish, near Stockport; and John Pickles & Sons, engineers, Hebden Bridge. Directors: C. J. Pfeiger, J. D. Haggie, G. Pickles, and W. Rowland. Registered office: 37, Cursitor Street, London, E.C.4.

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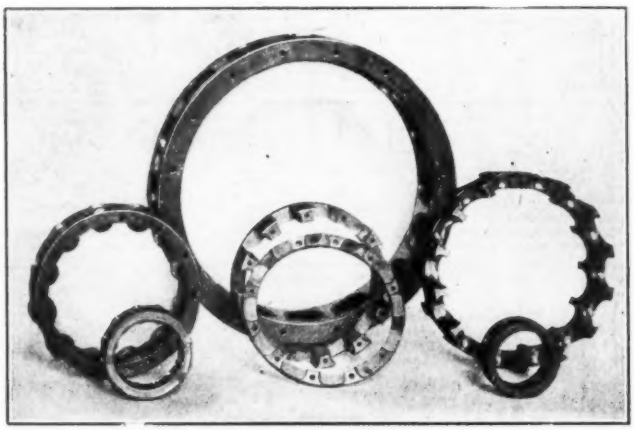
These were Die Cast on a **Monometer Die-Casting Machine** Dead to a Thou' by a leading Midland Firm.



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WE SUPPLY **THE** LEADING FIRMS IN THE TRADE WITH

FOUNDRY BLACKINGS

OF ALL KINDS

COAL DUST, CHARCOAL, PLUMBAGO and BLACK-LEAD CORE GUMS and all Foundry Requisites, and have done so since 1831.

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Our Specialite is Studying Special Requirements.

KINDLY HAND US YOUR ENQUIRIES.

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Ventilation of Ships, Buildings and Mines, Induced Draught on Boilers, Dust Removal, High Pressure Fans for Forge Fires and Cupolas, Air Washers for Cooling and Purifying the Air, Fans for Removing Fumes or Steam, Steam Heater Units for Heating Factories and Workshops.

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GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

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Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

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Telegrams: "LOWOOD, DEEPCAR."

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

Pig-Iron.

Hematite—	£ s. d.
East Coast Mixed Nos.	13 0 0
East Coast No. 1	13 2 6
West Coast Mixed Nos.	14 15 0
Scottish Mixed Nos.	14 5 0
Welsh Mixed Nos.	14 0 0
Cleveland—	
No. 1	11 17 6
No. 3 foundry G.M.B.	11 5 0
No. 4 foundry	11 5 0
No. 4 forge	11 5 0
Basic	11 15 0
Derbyshire, Leices., and Notts—	
No. 4 forge	13 5 0
No. 3 foundry	14 5 0
No. 2 foundry	14 6 6
No. 1 foundry	14 8 0
Basic	14 15 0
Northamptonshire—	
No. 4 forge	12 5 6
No. 4 foundry	12 12 6
No. 3 foundry	12 15 6
No. 2 foundry	12 17 0
No. 1 foundry	13 0 0
Basic	12 10 0
South Staffordshire, Shropshire and Worcestershire—	
Part-mine forge	13 7 6
Part-mine foundry	13 10 0
Common Staffs.	11 5 0
All-mine forge	14 7 6
All-mine foundry	14 12 6
Warm-air forge	13 12 6
Warm-air foundry	14 2 6
Cold blast	18 5 0
Basic	12 17 6
Scottish—	
Foundry, No. 3	13 10 0
All f.o.t. furnace	
Delivered in Manchester—	
*Derbyshire, No. 3	14 17 6
*Cleveland, No. 3	—
*Scottish, No. 3	15 0 0
* Merchant prices.	
Delivered in Sheffield—	
East Coast hematite	14 12 6
Derbyshire basic	—
Lincolnshire basic	14 15 0
Do. No. 3 foundry	—
Do. forge	—

High-Speed Tool Steel.

	s. d
Finished bars, 14 per cent. Tungsten	3 6
Finished bars, 18 per cent. Tungsten	4 3
Per lb. delivered buyers' works.	
Extras—	
Rounds and squares 3 in. to 8 in. inclusive	4d. per lb.
Rounds and squares under ½ in. to ¼ in.	3d. ,,
Flats under 1 in. by ¼ in. to ½ in. by ¼ in., and all sizes over four times 3 in width and over thickness	3d. ,,
Bevels of approved sizes and sections	6d. ,,
If in Coils	3d. ,,
Packing	4s. per cwt
Bars cut to length	10% extra
Scrap from High-Speed Tool Steel—	
Scrap pieces, 5d.	
Turnings and Swarf, 3d.	
Per lb. net, d/d steel-makers' works.	

Ferro-Alloys.

Ferro-Titanium—23/25% Ti. carbonless, 1/10.
Ferro-Tungsten.—75/80%, 3/–.
Ferro-Molybdenum.—70/80%, Mo., 9/6.
Ferro-Vanadium.—35/40%, Va., 52/6.
Metallic-Manganese,—98/99%, carbonless, 3/6.
(All per lb.).
Ferro-Phosphorus—20/25%, P. £50 0 0.
Ferro-Chrome.—4/6%, car., £46 0 0.
Ferro-Chrome.—6/8%, car., £41 0 0.
Ferro-Chrome.—8/10%, car., £42 0 0.
Ferro-Chrome —Specially refined, basis 60% chr., max. 2% car., £93 0 0.
Ferro-Silicon.—45/50% Si., £22 0 0 d/d. at Sheffield Steelworks.
Ferro-Manganese,—80%, £37 loose, £38 packed.
Export £15, according to destination.
(All per ton.)

Copper

	£ s. d.	£ s. d.
Standard cash	89 0 0	89 10 0
Three months	88 10 0	88 15 0
Electrolytic	97 0 0	99 0 0
Tough	97 0 0	99 0 0
Best selected	97 0 0	99 0 0
Sheets	154 0 0	—
India	154 0 0	—
American electrolytic spot	98 0 0	98 10 0
Do. Dec.	98 0 0	98 10 0
Official average price cash, Sept.		96 13 4½
Do. Three months, Sept.		97 5 11 13/16
Do. Settlement, Sept.		96 11 8 5/16
Do. Electro, Sept.		114 13 2 5/16
Do. B.S., Sept		106 17 6
Average spot price, copper, Sept.		96 11 1½
Do. Electro, Sept.		117 8 2½

Tin.

	£ s. d.	£ s. d.
Cash	267 5 0	267 15 0
Three months	269 10 0	270 0 0
English	261 0 0	262 0 0
Bars	263 0 0	264 0 0
Refined	—	—
Straits	—	267 0 0
Australian		265 0 0
Eastern		267 0 0
Banca		270 10 0
Official average price, cash, Sept.		270 7 3 5/6
Do. Three months, Sept.		276 4 2 5/6
Do. Settlement, Sept.		270 7 0 5/6
Average spot price, Sept.		270 5 8½

Spelter.

	£ s. d	£ s. d.
Ordinary	30 0 0	—
Remelted	30 10 0	—
Hard	25 0 0	25 10 0
Electro 99.9	46 0 0	—
English	42 10 0	—
India	32 10 0	—
Zinc dust 92 94%	80 0 0	85 0 0
Do. English	—	—
Zinc ashes, per cent. 70%	8 10 0	—
Official average price, Sept.		40 5 6 3/5
Average spot price, Sept.		39 13 3½

Lead.

Soft foreign (net)	36 7 6
English	37 10 0
Official average price, Sept.	35 7 6
Average spot price, Sept.	35 8 6½

Antimony.

English regulus	32 0 0 —
Chinese	40 0 0 —
Crude	33 0 0 —
Ore	Nominal.

Aluminium.

Virgin Metal 98/99—, per ton. 165 0 0

Phosphor Bronze.

Ingots.	Per ton.
Alloy No. I. or II.	—
III., IV., or V.	—
IV. or VII	—
VIII.	—
XI.	—
Cast Strips and Ingots	—
Castings.	**Per lb.**
I. or II.	—
III., IV. or V.	—
IV. or VII.	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid	—
,, Cored Bars	—

Delivery 2 Cwt. free to any town.
10 per cent. Phosphor Copper price B.S. £40 above
15 per cent. Phosphor Copper price B.S. £50 above
Phosphor Tin (5 per cent.) price of English Ingots. £30 above
Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAZELEY STREET MILLS, BIRMINGHAM.

*Chromium (Metallic).

98/99— purity, per lb. 6/6

*Nickel.

In cubes, 98/99— purity per ton £230 0 0

Nickel Silver.

	per lb.
Ingots for raising	1/7 – 2/–
Ingots for Spoons and Forks	1/7 – 2/–
,, rolled to spoon size	1/10 – 2/3

*Tungsten Metal Powder.

	per lb.
96/98— purity	3/8½

*Molybdenum Metal.

96/98— purity, per lb —

*Cobalt Metal.

97— purity, per lb. £ 1 5 0

Quicksilver.

75 lb. bottle 15 17 6

* Net, delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.	s. d	£ s. d.
Steel scrap, heavy melting	—	200
Iron scrap cast (cupola metal)	—	210
(London f.o.b.).		
Heavy steel		—
Light		—
Heavy cast		—

Steel Scrap.	Per ton. £ s. d.
Without Analysis—	
Heavy steel melting scrap	10 5 0
Steel planings, turnings and borings	9 15 0
Steel planings, turnings and borings mixed with wrought-iron or other material	9 10 0
Other classes of steel scrap, whether or not mixed	9 10 0
F.o.r. or in barge at nearest siding or wharf.	
With Analysis—	
Heavy steel melting scrap not over 0.04 per cent. p. and s.	10 10 0
Heavy steel melting scrap not over 0.05 per cent. p. and s.	10 10 0

Wrought-Iron Scrap.

	£ s. d.
(1) (a) W.I. plates and sections, not less than ¾ in. thick, reasonably clear of rivets, flanged ends, etc., suitable for shearing; cable scrap and chain scrap not less than ¼ in. dia.	10 10 0
(b) Heavy W.I. scrap not less than ¼ in. thick including horseshoes, rivets and bolts, and scrap therefrom	10 10 0
(c) W.I. scrap under ¼ in. thick, and all W.I. scrap not included in classes 1, 2 and 3	10 10 0
(2) Mixed W.I. scrap	9 0 0
(3) Wrought-iron planings, turnings and borings mixed with steel or other materials	7 10 0
(4) W.I. planings, turnings and borings	7 12 6

Cast-Iron Scrap.

	£ s. d.
Heavy ord., broken, between 1½ cwt. and 10 cwt. each	10 10 0
Heavy machinery, broken between 1½ cwt. and 10 cwt. each	10 15 0
Cold blast, broken, between 1½ cwt., and 10 cwt.	12 0 0
Ingot mould, unbroken	11 5 0
Do. broken, between 5 cwt. and 2 tons each	11 10 0
Do. between 1½ cwt. and 5 cwt. each	11 15 0
Railway chairs, whole or broken for remelting	10 5 0
Heavy lumps, not exceeding 2 tons each	9 17 6
Light	9 10 0
Burnt, broken ready for cupola	8 15 0
Burnt fire bars	9 5 0
Turnings and borings, for iron and steel makers	10 5 0

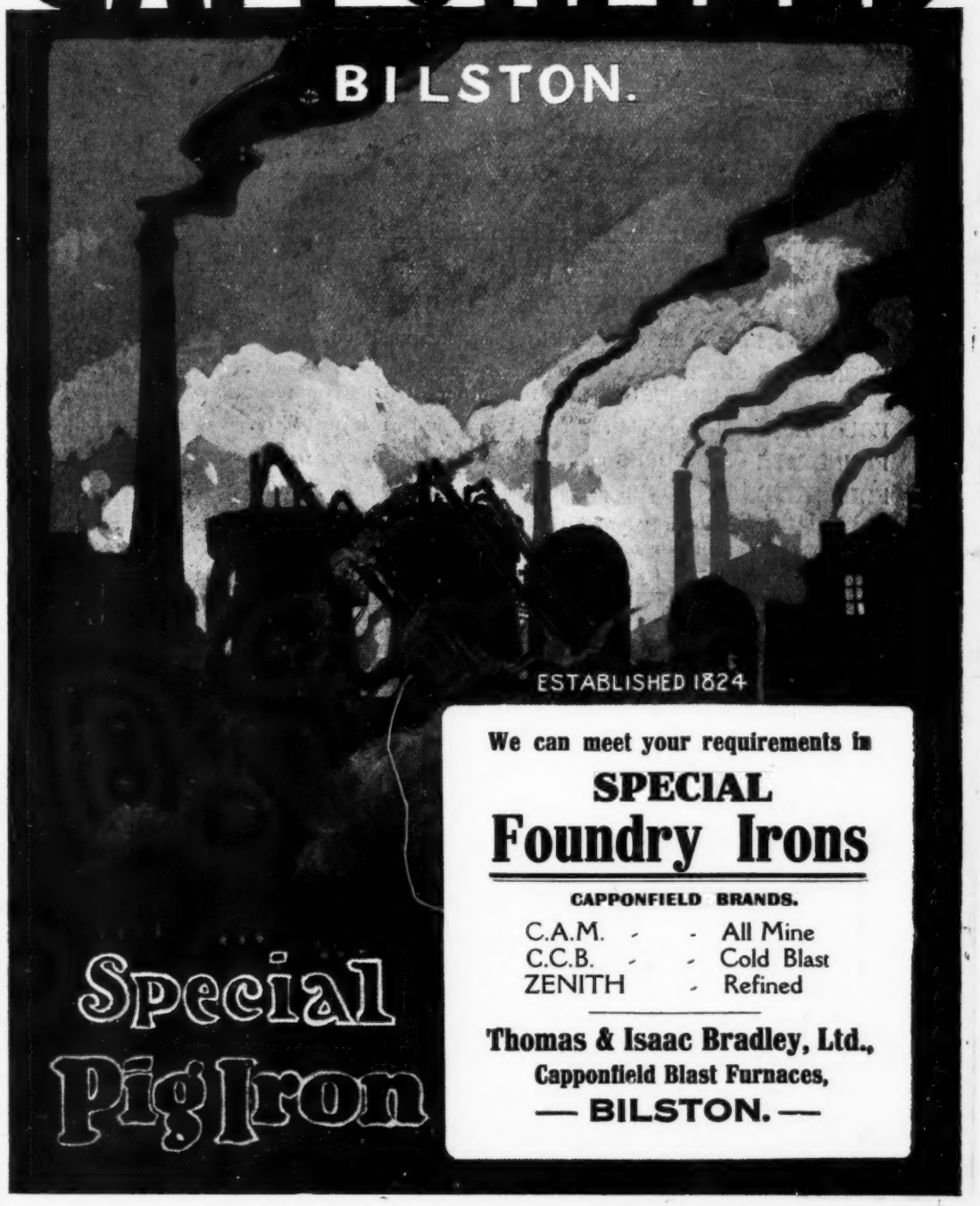
Old Metal.

London—	£ s. d.
Copper (clean)	75 0 0
Brass (clean)	46 0 0
Lead (less usual draft)	27 0 0
Tea lead	25 0 0
Zinc	21 0 0
New aluminium cuttings	110 0 0
Brazlery copper	62 0 0
Gunmetal	65 0 0
Hollow pewter	108 0 0
Shaped black pewter	100 0 0
(Above all d/d merchant's yard).	

Metallurgical Coke.

Durham and Northumberland—	£ s. d.
Blast furnace	3 2 9
Foundry	3 10 0
Lancs., Staffs., Yorks, Notts., Derbyshire, Lincolnshire and Midland Counties—	
Blast furnace	3 5 9
Foundry	3 17 9
F.o.t. at ovens.	

CAPPONFIELD



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SPECIAL

Foundry Irons

CAPPONFIELD BRANDS.

C.A.M.	All Mine
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Thomas & Isaac Bradley, Ltd.,
Capponfield Blast Furnaces,
— BILSTON. —

"FOUNDRITE."

"FOUNDRYMEN have been seeking this material for years."

Supplied only in 40 gallon Casks. No bulk broken.

FOUNDRITE *versus* CORE GUM.

FOUNDRITE is **the** binding material for moulding sand and cores.

FOUNDRITE SUPERSEDES and makes unnecessary all classes of **CORE GUM, LINSEED OIL and all other BINDING material.**

FOUNDRITE will renew old and burned sand, making it usable over and over **again.**

FOUNDRITE makes **CORES** unbreakable and the use **of core irons** unnecessary.

FOUNDRITE leaves **CORES** perfectly porous and does **not shrink.**

FOUNDRITE has been **"found right"** for all **Sand binding** in the Foundry **for all purposes.**

FOUNDRITE is supplied in **LIQUID** form ready for use. Dilute with Water.

The porosity of the core is perfect, and cores so made do not shrink.

No blowing, cracking, crumbling, honeycombing, or loss of strength can take place.

COST OF USING "FOUNDRITE."

For ordinary work the price is about One Penny per gallon.

FOUNDRITE is used in all important Foundries in Great Britain and the Continent.

FOUNDRITE SAVES MONEY.

FOUNDRITE PREVENTS WASTERS.

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CYLINDER PIG IRON.

FOR:

STEAM,
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Special Quality for:

AUTOMOBILE AND AERO ENGINES.

UNRIVALLED for Fluidity,
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▲2

EMERGENCY CUPOLAS and Standard Cupolas are supplied in all sizes, for outputs of 10 cwt. per hour and upwards. The illustration shows the smallest size we manufacture. Quotations for these, as well as for any apparatus forming part of the equipment of an up-to-date foundry, will be sent immediately upon receipt of particulars of requirements.

Fans, Blowers, Furnaces, Anvils, Vices, Smiths' Hearths, & Power Hammers.

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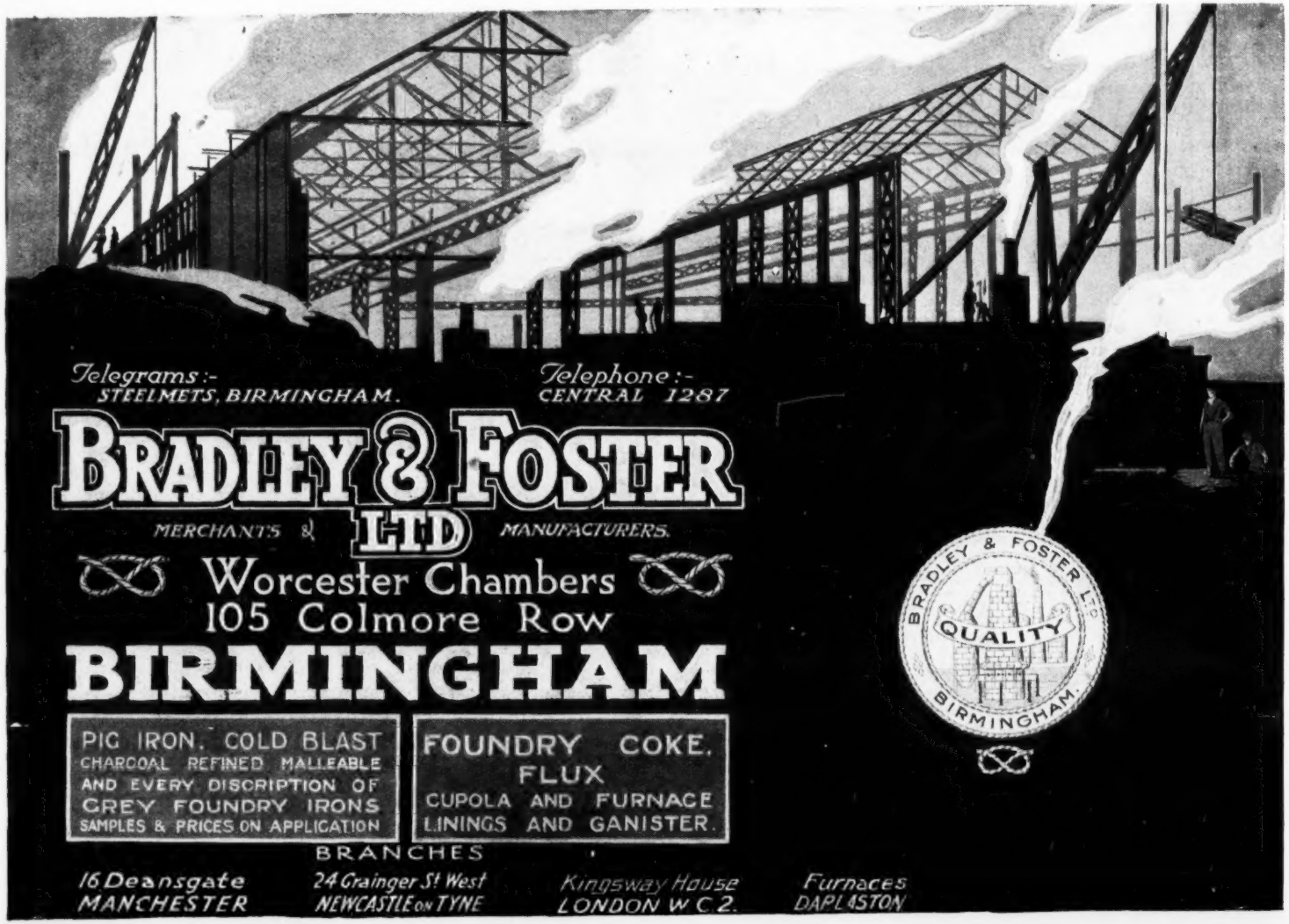
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"Rapid" Cupolas,

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Roots' Blowers,

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Charging Platforms,

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ECONOMICAL RESULTS GUARANTEED.

We are also Manufacturers of Steam Hammers, Smiths' Hearths, Centrifugal Pumps and Fans, High-Speed Engines and the "Bradford" Patent Boiler Feed Pump.

We are the original makers of "Rapid" Cupolas as under Stewart's Patent. We make this intimation as other makers are introducing this description, which had become established as a synonym of Stewart's Cupolas.

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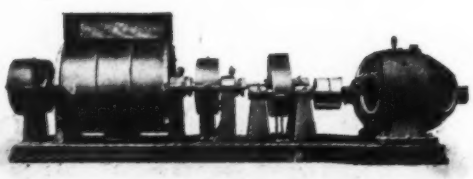

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This illustration shows our Ill. IV. Ladle Mounting. We are now making this as a Weldless Steel Stamping without a joint of any kind.

These special process Weldless Mountings are made for Ladles up to a 3 cwt. capacity. In the near future we shall be able to make them for much larger sizes, and we shall announce this when our plans are completed.

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INCREASED PRODUCTION

is wanted throughout the world.

FOR

IRON & STEEL CASTINGS

You obtain this result by using

"BALTISEED" (Regd.) CORE OIL.

Now in use in largest foundries in the country.

ONE CUSTOMER WRITES :—

Dear Sirs, 9th, Nov., 1920.

"Enclosed please find order for BALTISEED CORE OIL. We are glad to advise you that the result of using this core oil exceeds the promises that our foreman core maker held out for it, and we shall be glad if you can give us quick delivery."

We are, Sincerely Director.

AND MANY OTHERS WRITE IN SIMILAR TERMS.

BEING A STANDARD QUALITY EVERY BARREL IS GUARANTEED.

For particulars write . . .

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THE GREAT FIRMS OF

"The Scientific Oil for Cores"

has received support from all the great firms of the Foundry World—because it is absolutely reliable, scientifically prepared, and thoroughly tested before leaving our works.

It reduces Wasters to a minimum—lowers Fettling Costs, and produces Superior Cores in less time than by the ordinary methods and imitations.

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Foundry Economy

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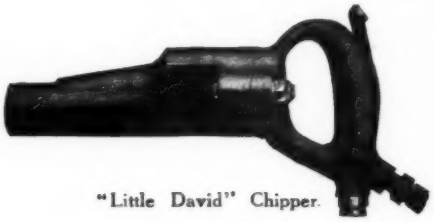

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"Little David" Sand Rammer.

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have been proved by actual users to be of real value in the foundry, performing their chosen tasks economically and well. There is a complete line of foundry tools built in various sizes and styles to meet all conditions of service. The line includes SAND RAMMERS that ram the moulds in a fraction of the normal time. CHIPPING HAMMERS and GRINDERS that trim the Castings cleanly and thoroughly. The "LITTLE DAVID" CORE BREAKER will efficiently break out Cores from Castings and will be found useful for any work of a similar nature. Each "Little David" Tool is an investment which will ensure good results.

FULL PARTICULARS SENT ON APPLICATION.

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HIGH EFFICIENCY

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The "PNEULEC" Jar Ram
Electrically Operated
MOULDING MACHINE.

Entirely Self-contained
Low Cost of Running
Capacity ½-cwt. to ½-ton
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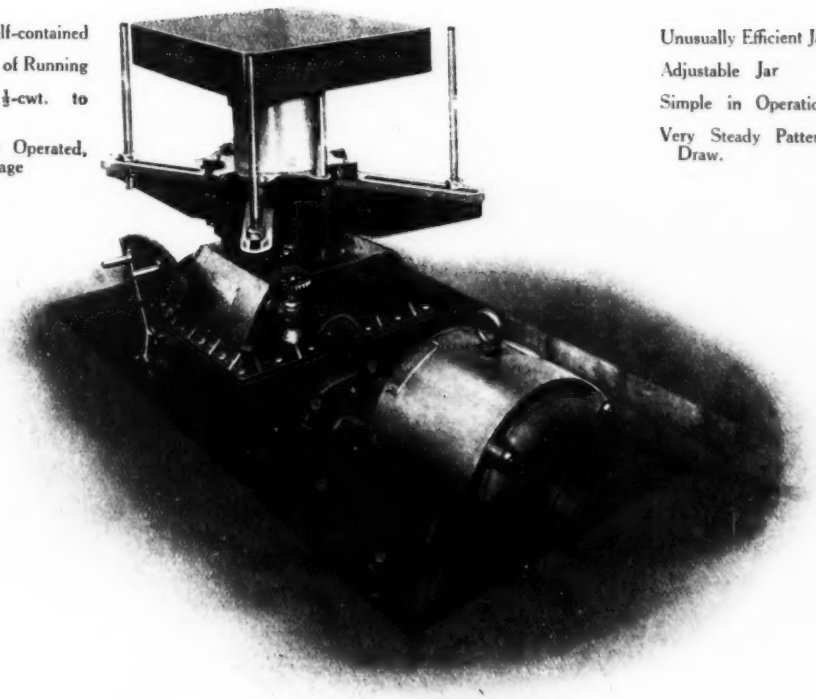

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WE specialise in making plates in a special metal for IRON AND BRASS CASTINGS for repetition work, the cost of which will be saved in pattern making alone. If you send us ONE GOOD PATTERN we will put you any number on plate according to the size. Present plates are being made to suit standard size of box (16″ x 12″ x 4″), but we can make the plate to suit your boxes if you send us a sample box. We are turning out hundreds of castings per day by this method, and are prepared to execute orders for CASTINGS IN IRON OR BRASS, in large quantities. Your enquiries are solicited, and will receive our prompt attention.

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Works—
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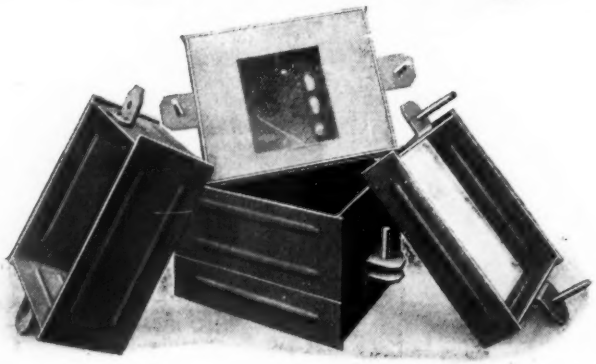
COMPSTALL ROAD, ROMILEY,
— NEAR STOCKPORT. —

Pressed Steel Moulding Boxes.



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Send us your order with name of your bank and we will forward you our System complete. You pay for it when you get it.

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Our Pure Mineral (Carbon)

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should have a place in every foundry. It may in some cases take the place of an expensive Plumbago, and if there happens to be a poor kind of ordinary Blacking on hand that disappoints, our Mineral Blacking mixed with it will improve it.

We are Importers of Belgian **CRUCIBLES.**

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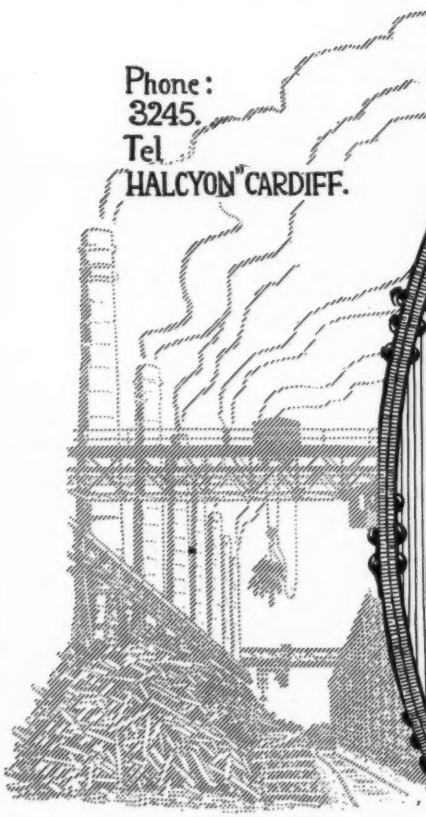

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SCRAP METALS
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RAILWAY WAGONS OF ALL KINDS
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PATTERNS AND MODELS OF ALL DESCRIPTIONS.

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PROMPT DELIVERY **PATTERNS** Estimates Free from DRAWINGS or CASTINGS

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80, PRINCESS STREET, LUTON, BEDS.

SPECIAL OFFER
OF
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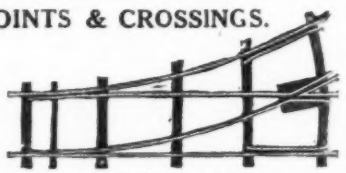

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Points and Crossings, as illustrated above, complete in 1 piece sets 14 lbs per yard Flange Rail ... ...per set £12 5 0
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MANY OTHER WEIGHTS AND LAY-OUTS IN STOCK.
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WRITE FOR LATEST GENERAL EQUIPMENT STOCK BULLETINS AND RAIL LISTS, POST FREE.

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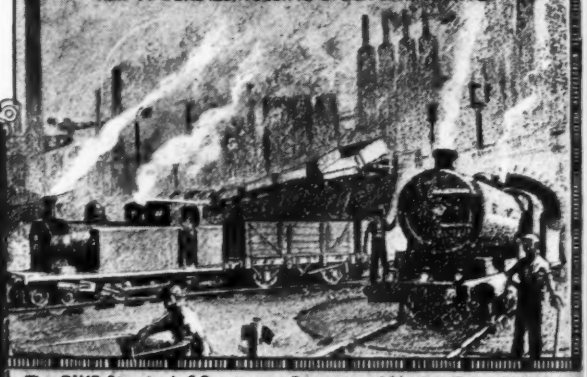

The B.W.S. Standard of Service is a Guarantee of Absolute Dependability, in both Manufactured and Merchanted Equipment, New or Second-Hand
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FOUNDRY FURNISHERS
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Of every description.

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Have you tried our

BLACKING ?

Our prices are not always the

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But our quality is always the

HIGHEST.

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Make your Cupola-lining
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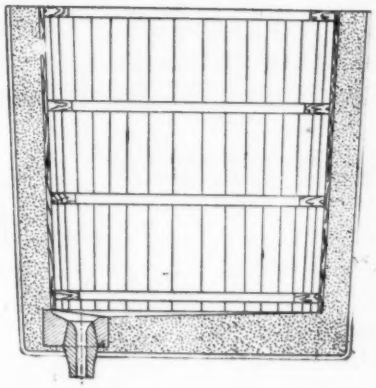
Lasts longer than the very best fire-brick.
CUPOLAS will last 10 Years without rebuilding.
LADLES will stand 80 Heats without relining.



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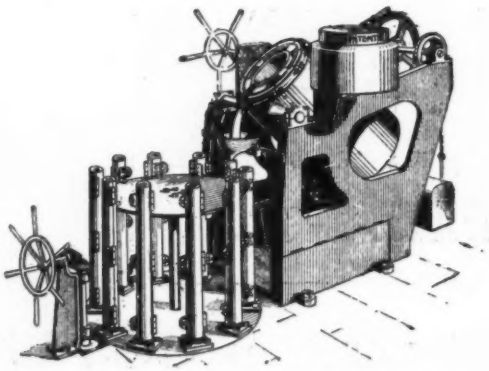
A clean, efficient, economical and labour-saving fuel for all types of oil-fired industrial furnaces and boiler plants.



Monometer Oil-Fired Furnace. Lip Axis Type, with Turntable and Moulds

Our Engineers are at your service for consultation.

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PLUMBAGO
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Cupola Fans

will enable you to bring down more metal per hour at a lower cost.

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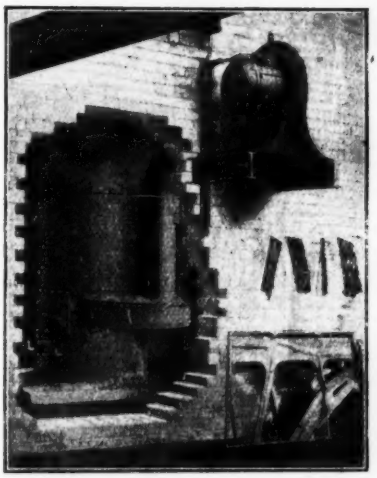

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COMPRESSED AIR

Has many uses in a Foundry, and undoubtedly one of the most valuable at the present time is its application to the riddling of Foundry Sand. Where moulding machines are employed (and most Foundries are equipped with one form or another of machine moulding) the rapid riddling of the sand is one of the first essentials if the fullest possible benefits are to be obtained. This is, of course, most particularly the case with our Ajax Jarring Moulding Machines, which, owing to the deep moulds made and the rapidity of operation, require a good supply of sand to be constantly ready. It must not, however, be supposed that the value of the

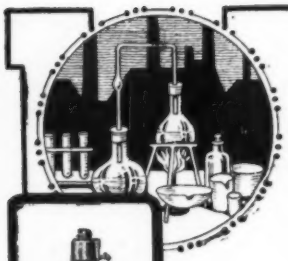
No. 2 size for foundry sand.
Discharges into two heaps.
Fine material passes through two screens.
See our Advertisement on Front Cover.

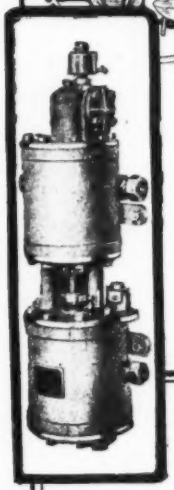
Pneumatic Sand Riddle

is confined to the machine equipped Foundry, as a little consideration will readily show how great its utility would be in any Foundry where a quantity of sand has to be riddled.

JOHN MACDONALD & SON, LTD.,

WATT STREET, MARY HILL, GLASGOW. **NORWICH UNION CHAMBERS, BIRMINGHAM.**
25, PILGRIM STREET, NEWCASTLE-UPON-TYNE. **6, ST. MARY'S GATE, MANCHESTER.**
WESTINGHOUSE BUILDINGS. 2/3, NORFOLK STREET, STRAND, LONDON, W.C 2.





WESTINGHOUSE AIR COMPRESSORS

HAVE AN UNEQUALLED REPUTATION FOR LONG AND RELIABLE SERVICE. . .

They can be hung on a wall or column or "tucked away" in a corner near the boiler, where they CAN BE RELIED UPON to keep up a continuous supply of compressed air—day and night if necessary—for the operation of all classes of pneumatic tools, sand blast machines, air hoists, rammers, moulding machines, oil and gas furnaces, &c., and with scarcely any attention beyond periodical replenishment of the lubricator.

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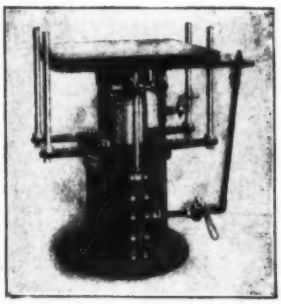
Telegrams:—"Westinghouse Phone, London." *Telephone:—240 North.*

British Moulding Machines
And FOUNDRY EQUIPMENT.



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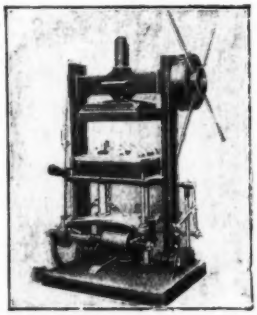

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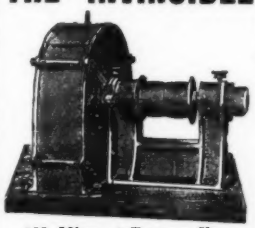
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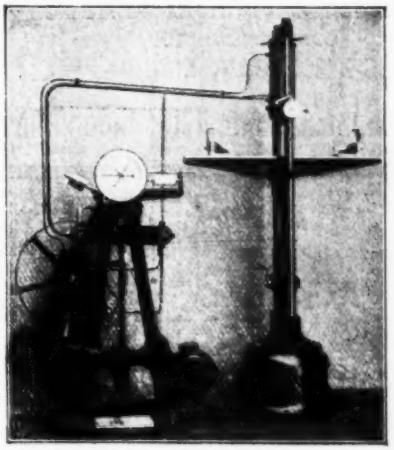

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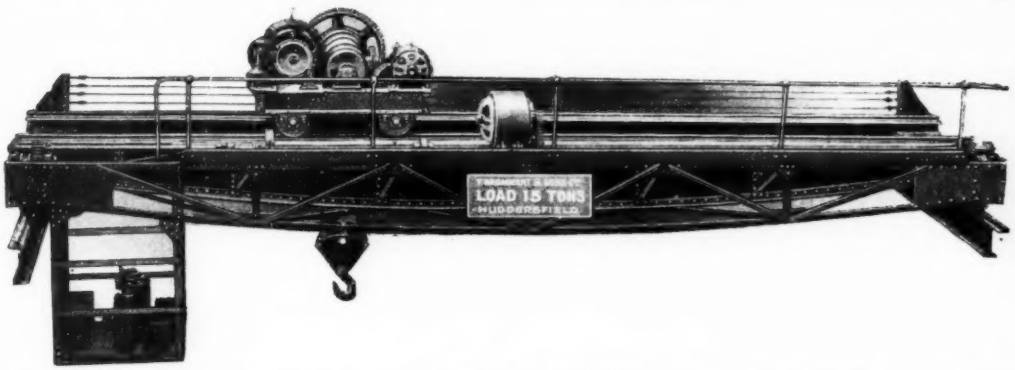

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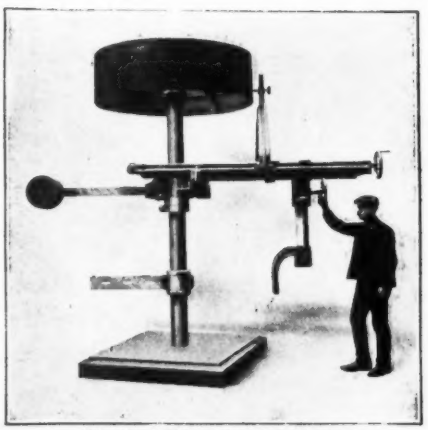

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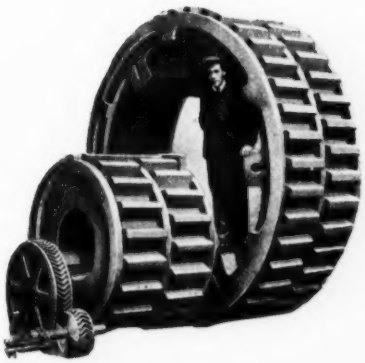

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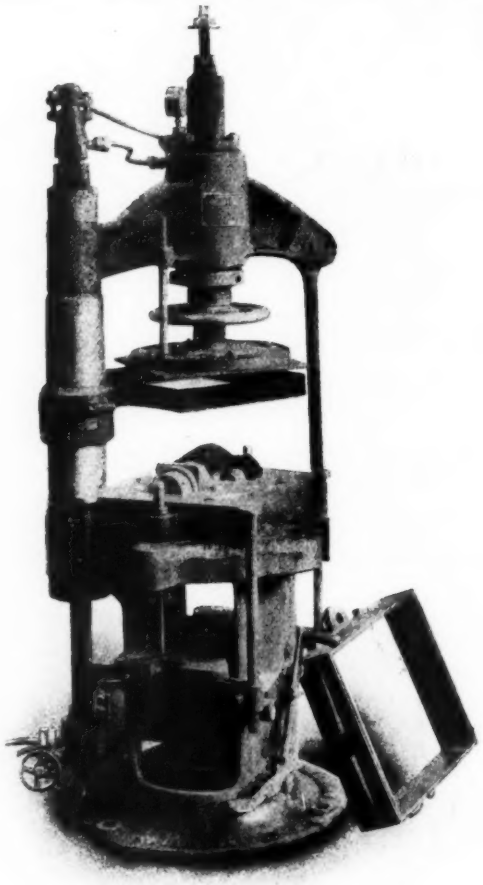

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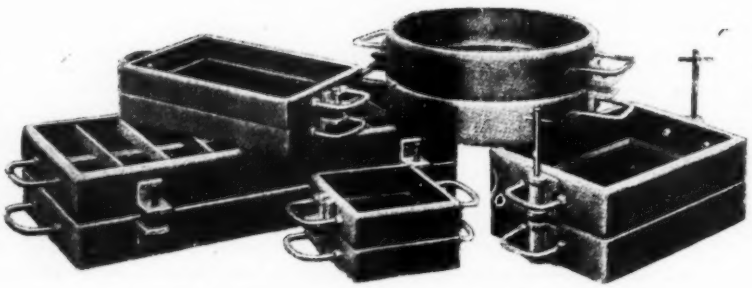

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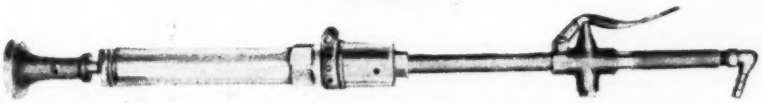

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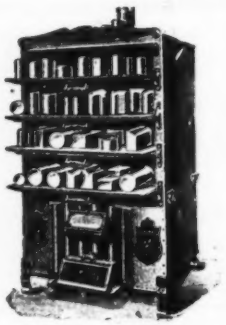

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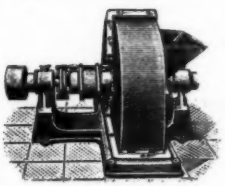

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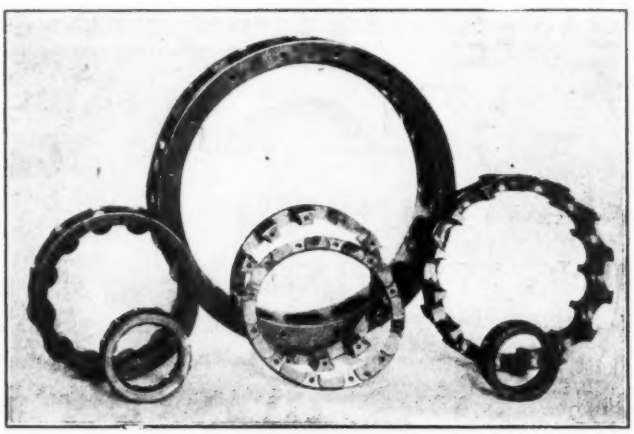

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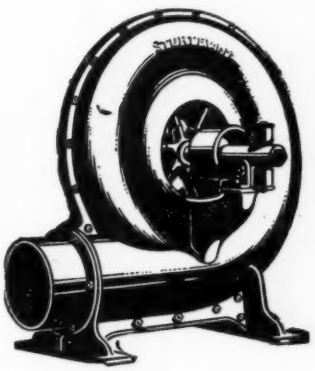

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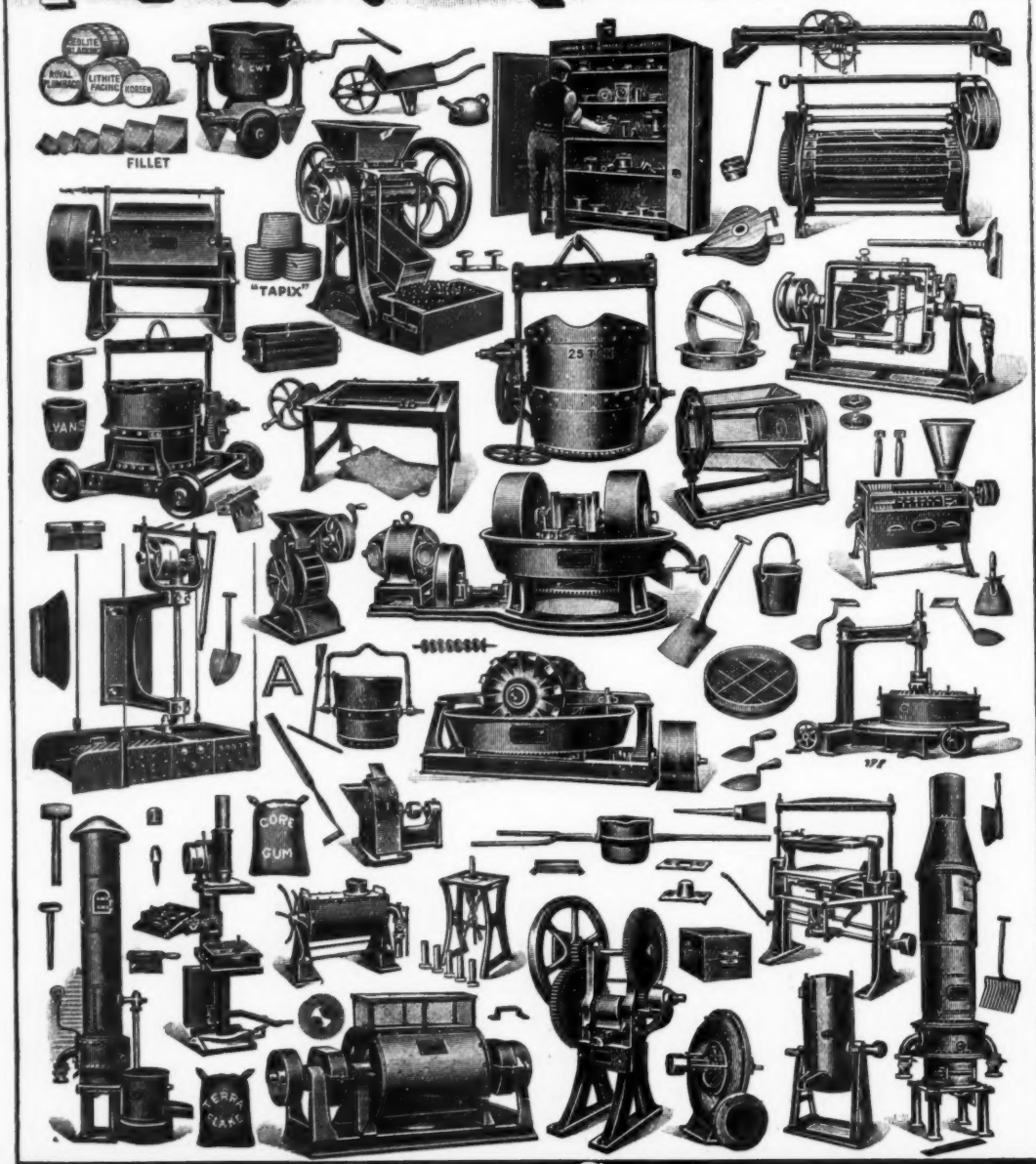

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